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FINAL REPORT ANNEX 23.
MULTI ZONE VENTILATION MODELS.
PARTICIPATION OF TNO BOUW. EXAMPLES.

1996 july 29

ing J.C. Phaff

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Samenvatting (Dutch)

Dit rapport is een overzicht van voorbeelden voor COMIS, binnen het kader van ANNEX 23, Multi zone Air Flow Models. Het is een afsluiting van het werk binnen de extensie ANNEX 23 1994-1996 en vormt daarmee de eindrapportage.

Een groot aantal verbeteringen en uitbreidingen zijn door TNO aangebracht in het operationele computerprogramma COMIS voor het simuleren van ventilatie van gebouwen.

COMIS vormt de 'motor' binnen een groep van programma's die wel wordt aangeduid met de naam COMIS, waarvan de belangrijkste COMERL (CH) en IISiBAT (Fr) zijn.

Het rapport bevat een reeks voorbeelden die laten zien hoe bepaalde ventilatie-aspecten in COMIS moeten worden gemodelleerd. Het is bedoeld voor de gebruiker van COMIS (inclusief ontwikkelaars van de COMIS programma's). Er wordt van uit gegaan dat de gebruiker van deze voorbeelden weet hoe een COMIS.CIF file moet worden gemaakt.

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Summary

This report is an overview of examples for COMIS by TNO Bouw within the framework of Annex 23, Multi zone Air Flow Models. It concludes the work in the extension ANNEX 23 1994-1996 and is the final report for the participation of TNO Bouw.

TNO has worked continuously on improvements and further extensions of the operational computer program COMIS. This program is a simulation program for ventilation of buildings.

COMIS is the central 'engine' in a group of programs called COMIS. The most important other programs in this group are COMERL (CH) and IISIBAT (Fr).

This report contains a series of examples. Each shows a certain aspect of building ventilation and how that can be modelled in COMIS. The examples are intended to be used by persons that work with COMIS or the developers of the programs within COMIS. Knowledge on how to use and create the COMIS.CIF file is assumed.

Table of Contents

1. INTRODUCTION

In this report the computer program COMIS version 2.1TNO has been used. This version is developed out of the official version 2.1 from the Operating Agent at LBL (USA) 1995 june [1]. COMIS2.1TNO will be used together with contributions from EMPA (CH) and CSTB (Fr) to create COMIS 3.0 .

A list of terms and names used in this report is explained in enclosure 1.

Although COMIS is a ventilation model which is supposed to do all imaginable ventilation network simulations, and the input can be pretty long and complex, the input can be kept very simple as well. To show the range from simple models to more complex ones a set of examples has been used. The idea behind it, is to explain a feature of COMIS in a working input file. To use all features together would create a long and less clear file. That is why more files are used here, sometimes partly a copy of an earlier example.

You can directly use an example in your COMIS directory. If you want to use exam12 then type:

take exam12 [ENTER]

edit/view COMIS.CIF (which then contains the example)

and/or run it. Type:

go [ENTER] (go is a batch file that starts COMIS)

COMIS has a few types of messages that appear in the COMIS.CER (COMIS ERror file) and the output file COMIS.COF (COMIS Output File or COF), which range from Note, Warning and Severe to Fatal Errors. At the end of COF the number of messages and severe messages is listed. You can loop along them by searching for '***CER***'.

The COMIS input file (called *.CIF) is an ASCII file which can be edited, or made by ComERL or IISiBat. The data is space and/or colon separated. A few things in this file make life easier. There is a possibility to have a header above all input items, that gives a clue about the data that is supposed to follow. The input is divided in sections by the use of keywords, which have

&- in the first two positions in a line.

A '#'or a';' makes the rest of a line comment.

Data in a line must use the same sequence as the header, but the columns don't have to be lined-up properly. If an in between value is unknown a 'd' can be placed instead to indicate to COMIS: Take the default. If there is less data in a line than in the header, COMIS takes its defaults.

Most keyword sections don't have to be in a fixed sequence, so while changing the input you normally don't have to worry about it. COMIS will report errors if you have to change the keyword section sequence.

In the next chapters the grayed text frames contain fractions of the input and output file. In most cases these grayed frames contain the parts that differ from the previous example.

Further explanation will be merged from contributions from the Annex 23 participants into the User Guide 3.0 [2].

Some interesting examples of the use of COMIS have been given in the previous Annex 23 report by TNO Bouw [3].

2. IMPROVEMENTS

Here follows the list of improvements by TNO in COMIS 2.1 from 1995 march to 1996 july.

This chapter is not a complete description of the new features and was written as a short summing up. A full description will follow in the COMIS User Guide [2].

Start and Stop time

At the start of the simulation conditions from Schedules and meteo are looked up from possible events (just) before the start time. In contrast with earlier versions you now don't have to make sure that every schedule has an event at the start time of the simulation.

If simulation start + stop time are missing they are derived from the meteo schedule if that contains full dates (year-month-day_).

Meteo

Meteo files re-open if they are cyclic and the simulation tries to read beyond the end/begin (A simulation from june 1996 to may 1997, crosses dec,jan. Meteo file has jan..dec and re-opens after dec 31 to continue at jan 01)

Meteo file may now have a (bufsec) interval > 32676 seconds (or >9 hour). The limit is now the same as for the simulation interval, 68 year. (Simulation periods may be long but occupants have a constant age in COMIS.)

New components

Kitchen hood, Related flow component (RF). RF is an Air Flow Component that will have a flowrate that is determined by the outcome of a given function (in CIF) using another link's flowrate as input. The system to assign a reference link is similar to that of T-junctions in duct systems. The reference link must come first in the &-NET-LINk keyword section.

Passive Stack, PS component. This is a natural exhaust duct (round or rectangular) with a cowl with a pressure coefficient that is a function of the ratio between the wind velocity and the velocity (and direction) through the duct.

Window opening

Window opening routine A27 (function of meteo). Windows can open if the schedule allows them to be open. With this function the opening fraction of a window (how far open) depends on the meteo. The name of the schedule must start with 'A27'. The A27 option has been copied to 'U01' and 'U02'. The routines U01 and U02 can be filled with additional functions that will be invoked by schedules with names starting with U01 or U02.

Pollutants

Multiple Pollutant schedules for the same pollutant, more schedules for one zone.

Steady state concentration option for all (parametric) calculations.

Test on too high concentrations, error warning and exits, to avoid a system crash.

Continuation input lines for room and occupant related source strengths.

Checks

Checks for non existing/misspelled Units and Quantities.

Better checks for wind profiles.

Checks if a fan curve is continuous (curve and straight line intercept).

Network checks for:
  non connected (groups of) zones
  at least one external/known pressure must be linked
  (not checked is the possibility that a link has a (scheduled!) zero conductance)

Occupant

- Occupant dosis, effective flowrates (based on pollutant 1) in histograms (uses internal Poltrans timesteps for increased tracking accuracy).

- Functions that define occupant mass, length, Dubois area, basal metabolism, CO_2, H_2O vapour production and O_2 consumption

- Occupant age is a constant throughout the simulation also for simulations that may span several years. This may seem a disadvantage but is sometimes wanted, i.e. how to examine a certain ventilation effect on 6 month old children if you need to use a one year meteo file.

Schedules

- Weekdays/Weekends for schedules. Use the acronyms WDY (working day) WND (weekend).

- Cp, meteo, all schedules with two headers, may now omit the name after their first CIF header. In earlier versions this lead to loss of the first actual schedule data line.

- Meteo file may now have a (bufsec) interval > 32676 seconds (>9 hour). The limit is now the same as for the simulation interval, 68 year.

Accuracy

- Improved stack pressure accuracy for non-horizontal links by using the barometric pressure as a function of height instead of a linear approximation.

- Recalculation of the air density in each zone per iteration step as option, to improve accuracy. This is useful if there are zones with a large (positive or negative) reference height.

Screen and output

- On Screen echo (selected in the input file) for time, progress, flow, pollutant, error.

- Number of timesteps and errors counted and printed in the COMIS Output File, COF.

- Output an (estimated) air velocity in openings and large openings. This is useful if one looks at possible draft complaints. This gives a better feel for the simulated problem.

- Selectable Flow matrix including external nodes (this is necessary for coupling with heat flow models).

- Selectable Debug output for the COMIS Direct Access File (DAF) and the COMIS Time Management System (TMS).

- Selectable Echo of all changes due to schedules in COF.

Histograms

Histogram definition in CIF: Number of classes, start and stop values for the class centers, User-Unit based. For effective flowrates (based on pollutant 1) in histograms the fictive sources can be assigned to the room, it's floor area, wall area or volume of the room.

Selection of histograms for dosis, flowrates and effective flowrates similar to the selection of COMIS Spreadsheet Output (CSO).

Calculation of the pollutant based histograms is done with the smaller Poltrans timestep for increased accuracy.

Histograms calculate:

- minimum, maximum and average values
- concentrations above the limit. This limit is defined in the input (unfortunately, if you model O2 and want to flag all concentrations below 20%, you get all above 20% as COMIS thinks of concentrations in terms of pollutants) flowrates below the limit.
- maximum frequency in any class, for ease of scaling.
- The frequencies are normalised, but the total time in each histogram is stored as well.

Output of histograms is in COF, similar to the T-option for CSO files.

General

No more User-Units in the Set file. Instead there is a new keyword section for User-Units, that may be used with more flexibility. One should be careful with the use of special units, the data typed in, must have that unit.

Restored the upper/lower case of User-Units.

Keywords and the file redirection ID 'F:' and 'f:' are now case insensitive.

COMIS now has a one/few lines explanation for each keyword and User-Unit.

Binary zero's in strings are handled as spaces in the GetW.. GetLdat routines.

or ; can be used to comment out a whole line but also the last part of a line. (not in schedule data lines)

Error messages

Error messages + problem description wrap at screen width and may now be very long.

Continuation messages (to list and explain errors and solutions).

GetWrd, RelCon IntCon now 'know' which variable they read, and tell this at errors. This gives a much better clue about how to solve the problem.

3. EXAMPLES.

Here follows a series of examples numbered 00 to 82 that have filenames exam00 to exam82. Every decade has some common topic. Not all subsequent numbers have been used per decade. Most examples show an increasing degree of complexity. No effort has been taken to give all examples a high degree of reality. Normal ventilation networks for real problems are too large for the explanation function of this report.

In this chapters the grayed text frames contain fractions of the input and output file. In most cases these grayed frames contain the parts that differ from the previous example.

Two types of examples are not included: Flow controller 3 and 4 and HVAC ducts. Work on these types is going on at EMPA (CH).

If this report was sent to you without the accompanying disc, you can get the examples by sending an e-mail to j.phaff@bouw.tno.nl subject:A23 examples.

A Glossary of terms and abbreviations is given in enclosure 1.

3.1. The simplest networks

exam00.cif

This is the shortest possible COMIS input file. It has two data lines, no zones and only one link. This is not really a ventilation network but it is powerful if you want to see what flow rate goes through a link at a certain pressure.

The list of pressures can be extended by adding lines with other fixed values as pressure difference.

In fact this example uses directly the output routines of COMIS as there is no pressure in the network to be solved.

Here follows the input file

exam00.cif

```
&-CR
*CR1         door
  ______________________________________________________________
 |1.|    Cs      |Exp n   | Lenght  |    Wall Properties     |
 |__|            |        |         | Thickness  | U-Value |
 |   (kg/s@1Pa)|  (-)   |  [m]    |    [m]     |[W/m2 K] |
 |_____________|________|_________|____________|_________|
      0.1         0.5
```

This defines the Air Flow Component (AFC) called a crack. Cs is the conductance and ExpN is the flow exponent.

```
&-NET-LINks
  _____________________________________________________________________
 |Link|Type | Zone No |  Height | Own  |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|      |    |  or  |____________________|
 |    |     |    |    |    |    |      |    |      |T-Junct.  Ref.Link  |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |   No    |  Angle   |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |   [-]   |  [deg]   |
 |____|_____|____|____|____|____|______|____|______|_________|__________|
 L1      CR1   1Pa  0Pa
 L2      CR1  10Pa  0Pa
```

Here are the links defined. A link is an air flow path. Each link uses one of the defined AFC's. Here CR1 (Crack 1) is used. The links have the ID's L1 and L2 but any (short) string can be used there. Most important is what is input below 'From' and 'To'. In principle 'From' and 'To' are the nodes (zone or external pressure) that are linked by this 'Link'. COMIS allows here to input directly a pressure, which must have the format: 'numberPa'. The unit is always Pa.

The output will contain a set of warnings because most of the input for a regular COMIS calculation is left out. Still the program produces correct results.

The output will contain a part with:

```
-------link--------------- --from--  ---to---   Tlink  Dp-link    from->to  velocity
nr    ID  type  Multiplier typ name  typ name    C      Pa          kg/s       m/s
-----------------------------------------------------------------------------------
  1 L1    CR1   1.E+00 z 1Pa     z 0Pa       20.    1.E+00       1.E-01      1.287
  2 L2    CR1   1.E+00 z 10Pa    z 0Pa       20.    1.E+01    3.162E-01      4.069
```

The most interesting column is the one with 'from->to' as header. It shows a flowrate of 0.1 kg/s at 1 Pa and the next line a flowrate of 0.316 kg/s at 10 Pa.

The last column contains an indication of the air velocity that would exist in the crack if it were an orifice like opening. This velocity is based on some assumptions and must not be used in further calculations, it is an indicator only.

The other columns are an echo of the input. The link temperature is dependent on the link type , wall width, flowrate and flow direction and the air temperatures of the linked nodes.

The input file can be minimized to :

```
#exam-0.cif
&-CR
*CR1 door
 0.1 0.5
&-NET-LINks
 L1     CR1  1Pa  0Pa
 L2     CR1  10Pa  0Pa
```

and still give the same result.

exam01.cif

This shows how to input a zone and two links. It is the smallest input file for a network.

exam02.cif

Here the option to echo all defaults that COMIS inserts in your input is used. The example is a copy of exam01.cif.

exam03.cif

The option to output all possible Keywords and User-Units is shown.

exam04.cif

Shows how to add a Title and Version.

exam05.cif

Shows the use of Wind pressures, Cp values and meteo conditions.

exam06.cif

Here Wind pressures, Cp values, meteo conditions and wind profiles are used.

exam07.cif

Wind pressures, Cp values, meteo conditions, wind profiles and external nodes are used.

exam08.cif

This example forms an introduction to the use of height(differences), Link Heights . The file is similar to exam01.

exam09.cif

Here also zones get different heights, Zone+Link Heights.

The part where the zones and links are defined, is:

```
&-NET-ZONes                         18
  ______________________________________________________________
 |Zone| Name          | Temp   |Ref.   |Vol   |Abs.   | Schedule |
 | ID |               |        | Height|      | Hum   |  Name    |
 | (-)|[-]            |  [oC]  |  [m]  | [m3] |[gr/kg]| [T./H..] |
 |____|_______________|________|_______|______|_______|__________|
 zon1     RM1             20.    3.2
```

Zones may work with very little data. COMIS needs the zone-ID as that is used in &-NET-LINk. Temperature is important if there are height differences and the flow through link has a temperature influence. The zone reference height can be used to move the reference plane for link heights in that zone. The volume is used for the output of the air change rate (ach) and determines the response time for changes in pollutant sources or concentrations.

```
&-NET-LINks                         22
  _____________________________________ _________________________________
 |Link|Type | Zone No |  Height | Own   |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|       |    |  or  |______________________|
 |    |     |    |    |    |    |       |    |      |T-Junct.  Ref.Link   |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |   No    |   Angle    |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |   [-]   |   [deg]    |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 L3      CR1  zon1 +5Pa  1.1  4.3
 L5      CR1  zon1 -4Pa -1.7  1.5
```

Here follows a part of the output:

```
At time = -4714dec30_01:00:00    Sunday  , interval =           0 seconds
 Meteo: Vmeteo=0.m/s Direction0.deg temp=10.C Xh=0. 1-iterations Solver=5
 Vbuilding=0.m/s
-------link------------ --from--  ---to---   Tlink  Dp-link    from->to  velocity
nr  ID   type    Multiplier typ name  typ name    C     Pa          kg/s       m/s
---------------------------------------------------------------------------------
  1 L3   CR1     1.E+00 z zon1    z +5Pa      15. -3.92E+00   -1.997E-01     -2.527
  2 L5   CR1     1.E+00 z zon1    z -4Pa      15.  3.92E+00    1.997E-01      2.526

 Zone-ID  pressure totalflow  infiltration ventilation  imbalance temperature
          Pa        kg/s        kg/s        kg/s         kg/s        C
------------------------------------------------------------------------------
 zon1     -38.480  0.1997      0.1997      0.           1.605E-12  20.

Total infiltration   =  0.1997064     kg/s
Total air change rate=   11.98238     1/h
Total building volume=   50.00000     m3

-Room groups- -----------flow rates--------  ------air change rates-------
 name   volume      inf      vent     total       inf      vent     total
           m3      kg/s      kg/s      kg/s      1/h       1/h       1/h
zo       50.0       0.2       0.0       0.2      12.0       0.0      12.0

COMIS finished. 1 timesteps.  There is one message, marked as ***CER***
```

As the zone is at 3.2 m the pressure there is about 36 Pa lower than at ground level. At Chapter 3.7, exam62 is explained how to get zone pressures with the outside pressure profile as reference, to reflect more the pressure hierarchy between the zones.

Note that at the last line COMIS shows how many timesteps it made and also how many errors there have been. Severe errors are mentioned separately. By searching for the ****CER**** string, all errors can be stepped through, which is useful in long files.

3.2. Links

exam10.cif

One crack used at more links and adapted for length/size

```
&-CR
*CR1     standard crack
  ________________________________________________________
 |1.|   Cs     |Exp n   | Lenght  |   Wall Properties    |
 |__|          |        |         | Thickness  | U-Value |
 |   (kg/s@1Pa)|  (-)   |  [m]    |    [m]     |[W/m2 K] |
 |_____________|________|_________|____________|_________|
      0.0005      0.5

&-NET-LINks                     22
  _____________________________________  _________________________________
 |Link|Type | Zone No |  Height | Own   |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|       |    |  or  |_____________________|
 |    |     |    |    |    |    |       |    |      |T-Junct.  Ref.Link   |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |  No    |   Angle    |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |  [-]   |   [deg]    |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 L3      CR1  zon1 +5Pa  d    d     d    10.2
 L5      CR1  zon1 -4Pa  d    d     d    14.8
```

Link L3 gets 10.2*0.0005 as C-value.

exam11.cif

One crack of given length/size used at more links and adapted for length/size

```
&-CR
*CR1     standard crack
  ________________________________________________________
 |1.|   Cs     |Exp n   | Lenght  |   Wall Properties    |
 |__|          |        |         | Thickness  | U-Value |
 |   (kg/s@1Pa)|  (-)   |  [m]    |    [m]     |[W/m2 K] |
 |_____________|________|_________|____________|_________|
      0.0005      0.5      10.2

&-NET-LINks                     22
  _____________________________________  _________________________________
 |Link|Type | Zone No |  Height | Own   |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|       |    |  or  |_____________________|
 |    |     |    |    |    |    |       |    |      |T-Junct.  Ref.Link   |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |  No    |   Angle    |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |  [-]   |   [deg]    |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 L3      CR1  zon1 +5Pa  d    d     d    10.2
 L5      CR1  zon1 -4Pa  d    d     d    14.8
```

Now L5 gets 14.8/10.2*0.0005 as C-value.

exam12.cif

One crack of given length/size used at more links and adapted for length/size

3.3. Zones

exam21.cif

Two zones. but not yet connected. An error is reported

```
&-NET-ZONes                        18
  _____________________________________________________________
 |Zone| Name          | Temp   |Ref.   |Vol   |Abs.   | Schedule |
 | ID |               |        | Height|      | Hum   |  Name    |
 | (-)|[-]            |  [oC]  |  [m]  | [m3] |[gr/kg]| [T./H..] |
 |____|_______________|________|_______|______|_______|__________|
 zon1     RM1            20.
 zon2  This_is_room2     20.

&-NET-LINks                        22
  _____________________________________  _________________________________
 |Link|Type | Zone No |  Height | Own   |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|       |    |  or  |_____________________|
 |    |     |    |    |    |    |       |    |      |T-Junct.  Ref.Link   |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |   No    |   Angle    |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |   [-]   |   [deg]    |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 L3      CR1  zon1 +5Pa  d    d     d    10.2
 L5      CR1  zon1 -4Pa  d    d     d    14.8


  NETWORK ERROR
  All zones should be connected, but here are  2 isolated groups of zones.
  You have to add links, or delete not-used zones from &-NET-ZONes.
  You have to add at least  1 link between those groups.
  Zones in group 0 are not in &-NET-LIN or are connected only to
  known pressure(s).
  Here follow the zones and the group they are in.
  Zone Group Zone name:
     1     0   zon1
     2     0   zon2
 ***CER*** SEVERE ***
 The Network is not properly connected:
 PROGRAM STOP
```

The network checker reports here that you have zones that are only connected to the outside, and that you have to make a link between zon1 and zon2.

exam22.cif

Two zones. but not properly connected. An error is reported

```
&-NET-ZONes                       18
  ______________________________________________________________
 |Zone| Name          | Temp   |Ref.   |Vol   |Abs.   | Schedule |
 | ID |               |        | Height|      | Hum   |  Name    |
 | (-)|[-]            |  [oC]  |  [m]  | [m3] |[gr/kg]| [T./H..] |
 |____|_______________|________|_______|______|_______|__________|
 zon1     RM1            20.
 zon2  This_is_room2     20.

&-NET-LINks                       22
  ___________________________________ _________________________________
 |Link|Type | Zone No |  Height | Own  |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|      |    |  or  |_____________________|
 |    |     |    |    |    |    |      |    |      |T-Junct.  Ref.Link   |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |   No    |   Angle   |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |   [-]   |   [deg]   |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 L3      CR1  zon1 +5Pa  d    d     d    10.2
 L5      CR1  zon1 -4Pa  d    d     d    14.8
 L6      CR1  zon2 -4Pa  d    d     d    10.2
 L7      CR1  zon2 +5Pa  d    d     d    14.8


  NETWORK ERROR
  All zones should be connected, but here are  2 isolated groups of zones.
  You have to add links, or delete not-used zones from &-NET-ZONes.
  You have to add at least  1 link between those groups.
  Zones in group 0 are not in &-NET-LIN or are connected only to
  known pressure(s).
  Here follow the zones and the group they are in.
  Zone Group Zone name:
     1     0   zon1
     2     0   zon2
 ***CER*** SEVERE ***
 The Network is not properly connected:
 PROGRAM STOP
```

Here we only added extra links to the outside and the error, and advice is the same. Make a link between zon1 and zon2.

exam23.cif

Two zones. Now correctly linked.

```
&-NET-ZONes                      18
  ______________________________________________________________
 |Zone| Name          | Temp   |Ref.   |Vol   |Abs.   | Schedule |
 | ID |               |        | Height|      | Hum   |  Name    |
 | (-)|[-]            |  [oC]  |  [m]  | [m3] |[gr/kg]| [T./H..] |
 |____|_______________|________|_______|______|_______|__________|
 zon1     RM1            20.
 zon2  This_is_room2     20.

&-NET-LINks                      22
  _____________________________________  _________________________________
 |Link|Type | Zone No |  Height  | Own   |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|       |    |  or  |_____________________|
 |    |     |    |    |    |    |       |    |      |T-Junct.  Ref.Link   |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |   No    |   Angle   |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]   |[-] | [Pa] |   [-]   |   [deg]   |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 L1     CR1  zon1 zon2
 L3     CR1  zon1 +5Pa  d    d     d    10.2
 L5     CR1  zon1 -4Pa  d    d     d    14.8
 L6     CR1  zon2 -4Pa  d    d     d    5.2
 L7     CR1  zon2 +5Pa  d    d     d    3.8
```

The output for this example is:

```
 At time =  1900jan01_00:00:00    Monday  , interval =           0 seconds
  Meteo: Vmeteo=0.m/s Direction0.deg temp=20.C Xh=0. 2-iterations Solver=5
  Vbuilding=0.m/s
 ----link-------------- --from-- ---to---   Tlink  Dp-link    from->to  velocity
 nr ID  type Multiplier typ name typ name    C     Pa           kg/s       m/s
 --------------------------------------------------------------------------------
   1 L1   CR1   1.E+00   z zon1   z zon2      20. -7.31E-02   -1.326E-05    -0.3479
   2 L3   CR1   1.02E+01 z zon1   z +5Pa      20. -6.06E+00   -1.231E-03     -3.167
   3 L5   CR1   1.48E+01 z zon1   z -4Pa      20.  2.94E+00    1.244E-03      2.206
   4 L6   CR1   5.2E+00  z zon2   z -4Pa      20.  3.01E+00    4.425E-04      2.234
   5 L7   CR1   3.8E+00  z zon2   z +5Pa      20. -5.99E+00   -4.558E-04     -3.148

  Zone-ID  pressure totalflow  infiltration ventilation  imbalance temperature
           Pa        kg/s        kg/s        kg/s         kg/s        C
 -------------------------------------------------------------------------------
  zon1      -1.060  0.001244    0.001231    1.326E-05    3.067E-09  20.
  zon2      -0.986  0.0004558   0.0004558   0.           2.442E-09  20.

 Total infiltration   =  1.6865653E-03 kg/s
 Total air change rate=  5.0596960E-02 1/h
 Total building volume=   100.0000     m3

 -Room groups- -----------flow rates--------  ------air change rates-------
  name    volume      inf      vent     total       inf      vent     total
            m3      kg/s      kg/s      kg/s      1/h       1/h       1/h
 zo      100.0       0.0       0.0       0.0       0.1       0.0       0.1

 COMIS finished. 1 timesteps.  There are 4 messages,marked as ***CER*** in your
 CER/COF file.
```

exam24.cif

Three zones. Again with a connection error.

```
 NETWORK ERROR
 All zones should be connected, but here are  2 isolated groups of zones.
 You have to add links, or delete not-used zones from &-NET-ZONes.
 You have to add at least  1 link between those groups.
 Zones in group 0 are not in &-NET-LIN or are connected only to
 known pressure(s).
 Here follow the zones and the group they are in.
 Zone Group Zone name:
    1     1   zon1
    2     1   zon2
    3     0   zn4
***CER*** SEVERE ***
The Network is not properly connected:
PROGRAM STOP
```

It may seem overdone to look at these errors, but even experienced users had untracable trouble due to a forgotten link. Now the program refuses to run these faulty inputs.

exam25.cif

Three zones.

```
&-NET-ZONes                      18
  _____________________________________________________________
 |Zone| Name          | Temp    |Ref.   |Vol   |Abs.   | Schedule |
 | ID |               |         | Height|      | Hum   |  Name    |
 | (-)|[-]            |  [oC]   |  [m]  | [m3] |[gr/kg]| [T./H..] |
 |____|_______________|_________|_______|______|_______|__________|
 zon1     RM1            20.
 zon2  This_is_room2     20.
 zn4   Added_room2       20.

&-NET-LINks                      22
  _____________________________________ _________________________________
 |Link|Type | Zone No |  Height | Own   |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|       |    |  or  |_____________________|
 |    |     |    |    |    |    |       |    |      |T-Junct.  Ref.Link   |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |   No    |   Angle    |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |   [-]   |   [deg]    |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 L1      CR1  zon1 zon2
 L3      CR1  zon1 +5Pa  d    d     d    10.2
 L5      CR1  zon1 -4Pa  d    d     d    14.8
 L6      CR1  zon2 -4Pa  d    d     d    5.2
 L7      CR1  zon2 +5Pa  d    d     d    3.8
 Link8   CR1  zn4  -4Pa
 Link9   CR1  zn4  +5Pa
 L10     CR1  zn4  zon2
```

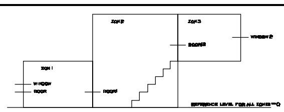
exam26.cif

Three zones, two levels.

```
&-NET-ZONes                       18
  ______________________________________________________________
 |Zone| Name          | Temp    |Ref.   |Vol    |Abs.   | Schedule |
 | ID |               |         | Height|       | Hum   |  Name    |
 | (-)|[-]            |  [oC]   |  [m]  | [m3]  |[gr/kg]| [T./H..] |
 |____|_______________|_________|_______|_______|_______|__________|
 zon1  level1            20.     0
 zon2  StairCase/Hall    20.     0
 zon3  level2            20.     0

&-NET-LINks                       22
  _____________________________________ _________________________________
 |Link|Type | Zone No |  Height | Own  |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|      |    |  or  |_____________________|
 |    |     |    |    |    |    |      |    |      |T-Junct.  Ref.Link   |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |   No    |   Angle   |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |   [-]   |   [deg]   |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 door   CR1  0Pa  zon2  1.1 1.1
 doorI  CR1  zon2 zon1  1.1 1.1
 window CR1  zon1 0Pa   1.5 1.5
 doorI2 CR1  zon2 zon3  4.1 4.1
 window2 CR1 zon3 0Pa   4.5 4.5

 vent   CR1  zon1 0Pa   1.0 6.5
```



Cross section of example 26.

exam27.cif

Three zones, two levels. Level 2 at 3.0 m . &-PR-CONTrol: UseOPz=1 . There is a small difference versus exam26.

```
&-PR-CONTrol parameters            4        --- OPTIONAL DATASECTION ---
  _____________________________________________________________________
 |1.| Under |     T  o  l  e  r  a  n  c  e  s   |Start  |Link Flow   |
 |__| Relax-|___________________________________|Number |Pressure    |
 |    ation | absolute   | Relative |CORR*JAC(i,i)|of Ite-|Laminar Flow|
 |    Factor|  EpsFA     |  EpsFR   | EpsCJ       |rations|DifLim      |
 |    [-]   |  [kg/s]    |  [-]     |  [kg/s]     |  [-]  |   [Pa]     |
 |__________|___________|__________|_____________|_______|____________|
     1          d            d          d           d        d
  _____________________________________________________________________
 |2.|   use old  |No Pressure   | Solver Selector           |Max       |
 |__|  Pressures |Initialization|                           |Number of|
 |               |              |0=optimum relax COMIS      |Iterations
 |0=Zero         |0=Lin.initial.|1=Newton (with given Relax)|allowed   |
 |  Pressures    |1=No initial. |2=Newton Steffensen        |          |
 |1=use          |              |3=Walton Steffensen        |          |
 |  Previous     |              |4=One avg. Steffensen      |          |
 |               |              |5=Walton 2 fixed relax.fact|          |
 | UseOPz        |NoInit        |        SlvSel             | Miter    |
 |     [-]       |     [-]      |         [-]               |  [-]     |
 |_______________|______________|___________________________|__________|
    1                 d              d                         d
```

This difference is minimized at a second calculation (timestep) while not resetting the zone pressures to zero (effect of UseOPz=1).

exam28.cif

Three zones, two levels. &-PR-CONTrol: UseOPz=2 recalculates the stack pressure in the iteration loop. The stack pressure used is in tis case from the previous iteration step. In general there is not much difference between these two last steps and the results will be accurate.

```
&-PR-CONTrol parameters           4        --- OPTIONAL DATASECTION ---
  _____________________________________________________________________
 |1.| Under |     T  o  l  e  r  a  n  c  e  s   |Start  |Link Flow   |
 |__| Relax-|____________________________________|Number |Pressure    |
 |    ation | absolute  | Relative |CORR*JAC(i,i)|of Ite-|Laminar Flow|
 |    Factor|  EpsFA    |  EpsFR   | EpsCJ       |rations|DifLim      |
 |    [-]   |  [kg/s]   |  [-]     |  [kg/s]     |  [-]  |   [Pa]     |
 |__________|___________|__________|_____________|_______|____________|
    1          d            d          d           d        d
  _____________________________________________________________________
 |2.|   use old  |No Pressure   | Solver Selector            |Max      |
 |__|  Pressures |Initialization|                            |Number of|
 |               |              |0=optimum relax COMIS       |Iterations
 |0=Zero         |0=Lin.initial.|1=Newton (with given Relax)|allowed  |
 |  Pressures    |1=No initial. |2=Newton Steffensen         |         |
 |1=use          |              |3=Walton Steffensen         |         |
 |  Previous     |              |4=One avg. Steffensen       |         |
 |               |              |5=Walton 2 fixed relax.fact|         |
 | UseOPz        |NoInit        |        SlvSel              | Miter   |
 |     [-]       |     [-]      |          [-]               |  [-]    |
 |_______________|______________|____________________________|_________|
   2                  d              d                           d
```

3.4. Schedules and external files

exam31.cif

One zone with the use of time and a meteo schedule.

```
&-SCH-METeo data                 36        --- OPTIONAL DATASECTION ---
  _________________
 |1.|DATASET NAME  |
 |__|______________|
  meteo-test
  _____________________________________________________________________
 |2.|TIME              |        WIND       |TEMPERATURE|HUMIDITY|BAROMETER|
 |__|                  |___________________|           |        |PRESSURE |
 |                     | SPEED   |DIRECTION|           |        |ABSOLUTE |
 |[-]                  |[m/sec]  |[deg]    |[oC]       |[gr/kg] |[kPa]    |
 |_____________________|_________|_________|___________|________|_________|
  1996may21_10:00        10         0           20
  1996may21_11:00        11         0           20
```

exam32.cif

One zone with a fan schedule and a meteo schedule.

```
&-SCH-FAN schedules              26        --- OPTIONAL DATASECTION ---
  _________________________________________________________
 |Schedule    |     Time              |       Fan Speed      |
 |*Name       |                       |         Factor       |
 | (-)        |     (-)               |          (-)         |
 |____________|_______________________|______________________|
*FA1              monday                         1.15
                  tuesday                        0.55
```

exam33.cif

One zone with a fan schedule from a file.

```
&-SCH-FAN schedules                26        --- OPTIONAL DATASECTION ---
  ________________________________________________________
 |Schedule   |     Time              |       Fan Speed       |
 |*Name      |                       |         Factor        |
 | (-)       |     (-)               |          (-)          |
 |___________|_______________________|_______________________|
; The two commented lines are litterally in the file fan33
;*FA1              monday                      1.15
;                  tuesday                     0.55
F: FA1 fan33
```

exam34.cif

One zone with a fan schedule and a meteo schedule from a file.

```
&-SCH-METeo data                   36        --- OPTIONAL DATASECTION ---
  _________________
 |1.|DATASET NAME  |
 |__|______________|
F:  meteo34
  ____________________________________________________________________
 |2.|TIME              |       WIND        |TEMPERATURE|HUMIDITY|BAROMETER|
 |__|                  |___________________|           |        |PRESSURE |
 |                     | SPEED  |DIRECTION|           |        |ABSOLUTE |
 |[-]                  |[m/sec] |[deg]    |[oC]       |[gr/kg] |[kPa]    |
 |_____________________|________|_________|___________|________|_________|
```

The meteo file meteo34 is:

```
  1996may19_23:00     8        0          20
  1996may20_11:00     9        0          20
  1996may20_11:31    10        0          20
  1996may22_11:00    11        0          20
```

In fact there would be a performance difference if you would insert a long meteo schedule into COMIS.CIF. It is then sorted and copied into COMIS.DAF, while external schedule files are not sorted and copied.

exam35.cif

One zone with a fan and meteo. Fixed timesteps in the meteo file.

```
&-SCH-METeo data                   36        --- OPTIONAL DATASECTION ---
  _________________
 |1.|DATASET NAME  |
 |__|______________|

  F: meteo35
```

The meteofile meteo35 is:

```
*  1996may19_23:00  43200
   10        0          20
   11        0          20
```

It has a start time and a fixed interval. If the interval is omitted 3600 s is taken as default.

3.5. Pollutants

Note that at a time step where the source strengths change, the concentrations at that time are caused by the interval before. In the next interval (at the following timestep) you might see the effect of the changed sources.

There is still an improvement coming up for COMIS for the input of volumetric pollutant source strengths. Until now the molar mass is not invoked at the conversion from input pollutant source strengths. Therefore mass flowrates have to be used for pollutant source strengths.

exam41.cif

One zone with a pollutant.

```
&-PR-SIMUlation options        3
                 STARTtime  1996may19_23:00
                  STOPtime  1996may22_11:00
 POL 1
&-NET-ZP zone-pollutants  20                      --- OPTIONAL DATASECTION ---
  _________________________________________________________
 |ZONE    |              POLLUTANT                         |
 |        |________________________________________________|
 | *NR    | INITIAL        | SOURCE               | SINK     |
 |        | CONCENTRATION  |                      |          |
 |[-]     |[kg/kg]         |[kg/s]                |[m/s*m2]  |
 |________|________________|______________________|__________|
*zon1       0.E-6            0.001                 0.00
            0.E-6            0.0                   0.00
;there may be up to 5 lines of pollutant here for pollutant 1..5
```

exam42.cif

One zone with a scheduled pollutant.

```
&-SCH-SOUrce schedules


  ___________________________________________________________
 |Schedule           | time               | Source Factor      |
 |*Names             |                    |                    |
 |           (-)     |   (-)              | (-)                |
 |___________________|____________________|____________________|
*QCO2        0:00          1
             8:30          2
             9:00          1
```

exam43.cif

One zone with a scheduled pollutant. Concentration Table output.

```
 POL 1
# output schedule name, time and variation
EchoSCHEDULES
 C1-S  zon1
 C1-T  zon1
```

The output in file C1xx.CSO is (here copied to exam43.CSO)

```
kg/kg                C1-S
       0       zon1
35204.958333   0.000E+0
35205.000000   0.214E-2
35205.354167   0.241E-2
35205.375000   0.349E-2
35206.000000   0.241E-2
35206.354167   0.474E-2
35206.375000   0.598E-2
35207.000000   0.475E-2
35207.354167   0.497E-2
35207.375000   0.622E-2
35207.458333   0.537E-2
```

Column '0' holds the time in LOTUS 1900 format day.time. The first data column is for 'zon1'. The first line of the file tells that this histogram contains C1, the first pollutant in this simulation.

exam44.cif

One zone with a scheduled pollutant and an outside pollutant schedule.

```
&-SCH-POL outdoor concentration data  38    --- OPTIONAL DATASECTION ---
  _________________
 |1.|DATASET NAME  |
 |__|______________|
   outside_pol_Schedule
  ______________________________________________________________________
 |2.| Time       |     Pollutant  Concentration                         |
 |__|            |______________________________________________________|
 |               |  No1      |  No2      |  No3      |  No4      |  No5      |
 |    (-)        | (kg/kg)   | [kg/kg]   | [kg/kg]   | [kg/kg]   | [kg/kg]   |
 |_______________|___________|___________|___________|___________|___________|
  1996may19_23:01     0.0001  0.00001
  1996may22_00:01     0.0      0.0
```

exam45.cif

One zone with a scheduled pollutant and an outside pollutant schedule for given external nodes.

```
&-SCH-POL outdoor concentration data  38    --- OPTIONAL DATASECTION ---
  _________________
 |1.|DATASET NAME  |
 |__|______________|
   outside_pol_Schedule
  ______________________________________________________________________
 |2.| Time      |     Pollutant  Concentration                          |
 |__|           |_______________________________________________________|
 |              |  No1      |  No2      |  No3      |  No4      |  No5      |
 |    (-)       | (kg/kg)   | [kg/kg]   | [kg/kg]   | [kg/kg]   | [kg/kg]   |
 |______________|___________|___________|___________|___________|___________|
  1996may19_23:01     fef 1=0.0001  1=0.00001
  1996may22_00:01      0.0      0.0
```

exam46.cif

One zone with a scheduled pollutant and an outside pollutant schedule for given external nodes. Steady state concentrations for every condition.

```
 2VENT
# FB-S
 POL 2
 STEADY
```

exam47.cif

Three zones with 3 pollutants. More than one schedule per pollutant and more than one schedule per zone.

```
&-NET-ZONes                       18
  ______________________________________________________________
 |Zone| Name          | Temp    |Ref.   |Vol    |Abs.   | Schedule |
 | No |               |         | Height|       | Hum   |  Name    |
 | (-)|[-]            |  [oC]   |  [m]  | [m3]  |[gr/kg]| [T./H..] |
 |____|_______________|_________|_______|_______|_______|__________|
  RoomA  living        18.5      0.0     100      0      Q1CO2/Q1For/Q1H2O
  RoomB  kitchen       18.5      0.0     100      0      Q2CO2/Q2H2O
  RoomC  hall          18.5      0.0     100      0      Q55CO2/Q3For/Q45H2O

&-NET-ZP zone-pollutants  20                      --- OPTIONAL DATASECTION ---
  _________________________________________________________
 |ZONE     |              POLLUTANT                        |
 |         |_______________________________________________|
 | *NR     | INITIAL        | SOURCE                | SINK     |
 |         | CONCENTRATION  |                       |          |
 |[-]      |[kg/kg]         |[kg/s]                 |[m/s*m2]  |
 |_________|________________|_______________________|__________|
*RoomA       1000.E-6            5.6E-6                 0.00
                0.2E-6           0.0E-2                 0.00
            11000.E-6            0.E-2                  0.00
*RoomB       2000.E-6            0.E-2                  0.00
                0.1E-6           0.2E-2                 0.00
            21000.E-6            0.E-2                  0.00
# must be hot in RoomB to allow so much water (COMIS does not check over
# saturation/condensation)
*RoomC       1000.E-6            0.E-2                  0.00
                0.15E-6          0.5E-2                 0.00
            11000.E-6            0.E-2                  0.00


&-SCH-SOUrce schedules
  ____________________________________________________________
 |Schedule            | time               | Source Factor or    |
 |*Names              |                    | Number of occupants|
 |            (-)     |    (-)             | (-)                 |
 |____________________|___________________|_____________________|
*Q1CO2        0:00          10.0
              4:30          10
              9:00          10
             10:00          10
*Q1For        0:00          1
              4:30          1
              9:00          1
             10:00          1
...
&-POL-DEScription                     37          --- OPTIONAL DATASECTION ---
  _________________________________________________________
 | NR  |NAME                  |MOLAR MASS|Diffusion|Conc    |
 |[-]  |[-]                   |[gr]      | [m2/s]  |Limit   |
 |     |                      |          |         |[kg/kg] |
 |     |                      |          |         |        |
 |_____|______________________|__________|_________|________|
   1    CO2mayAddName              44
   2    Formaldehyde...            30
   3    H2Opure                    18
```

exam48.cif

Two zones with an occupant as source, that moves from room to room and out of the building. O2 has been added as pollutant 2.

```
&-NET-ZP zone-pollutants  20                      --- OPTIONAL DATASECTION ---
   ___________________________________________________________
  |ZONE    |              POLLUTANT                         |
  |        |________________________________________________|
  | *NR    | INITIAL       | SOURCE               | SINK     |
  |        | CONCENTRATION |                      |          |
  |[-]     |[kg/kg]        |[kg/s]                |[m/s*m2]  |
  |________|_______________|______________________|__________|
*zon1       0.E-6            0.0                  0.0
            0.2325           0.0                  0.0
*zon2       0.E-6            0.0                  0.0
            0.2325           0.0                  0.0

&-SCH-POL outdoor concentration data  38    --- OPTIONAL DATASECTION ---
   ______________________________________________________________________
  |2.| Time      |     Pollutant  Concentration                          |
  |__|           |_______________________________________________________|
  |              |  No1      |  No2      |  No3      |  No4      |  No5       |
  |    (-)       | (kg/kg)   | [kg/kg]   | [kg/kg]   | [kg/kg]   | [kg/kg]    |
  |______________|___________|___________|___________|___________|____________|
1996may19_23:59       0.0   0.2325

&-POL-DEScription                     37          --- OPTIONAL DATASECTION ---
   ________________________________________________________
  | NR  |NAME                 |MOLAR MASS|Diffusion|Conc    |
  |[-]  |[-]                  |[gr]      | [m2/s]  |Limit   |
  |     |                     |          |         |[kg/kg] |
  |     |                     |          |         |        |
  |_____|_____________________|__________|_________|________|
    1    CO2                    44        2E-5      3.95E-4
    2    O2                     32        2E-5      2E-5
```

Here is shown how to move an occupant from one zone into another. If you use &-PR-SIMU: DEBUG, every change in a schedule is reported together with the new value of the changed variable.

At '...' further schedules are left out. Note that the first number after 'Q' in &-NET-ZONes is a number to differentiate between the schedules that use one and the same pollutant. From the first alphabetical character after that number the name of the pollutant schedule mus match exactly on one of the pollutans defined, i.e. Q1CO2 is schedule number 1 for pollutant CO2, Q45H2O is a schedule, with number 45, for pollutant H2O. There are no 45 schedules for H2O, you may choose any number that is convinient. Note further that the schedule name is kept short (there is not so much space there) and the defined pollutant name at &-POL-DEScription may be longer and give a more clear description of the substance.

exam49.cif

One zone with an occupant as source. CO2 and O2 as pollutant. The flowrate through the zone is about 0.007 m3/s.

```
&-SCH-OCCupant schedules         31             --- OPTIONAL DATASECTION ---
  _____________________________________________________________________
 |SCHEDULE | TIME               |ZONE     |ACTIVITY LEVEL |Number of |
 |*NAME    |                    |NR       |FACTOR  (-)    |occupants |
 |[-]      |[-]                 |[-]      |[-]            |[-]       |
 |_________|____________________|_________|_______________|__________|
; occupant is in zone 2
*OCC1              00:00:00     1         1.0             1
; occupant moves out of the building
                   12:30:00     1         0.0             0
; occupant comes back in zone 1
                   15:30:00     1         1.0             1


 Steady state solution:
 ----------------------

  1996may21_00:00:00   Tuesday Pollutant Nr.           1(CO2)
 Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
          kg/s       kg/s             kg/s        kg/kg
     1.00         1.00               1.00         1.00
 ----------------------------------------------------------
   zon1    0.         5.E-06       1   0.            0.0006508

  1996may21_00:00:00   Tuesday Pollutant Nr.           2(O2)
 Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
          kg/s       kg/s             kg/s        kg/kg
     1.00         1.00               1.00         1.00
 ----------------------------------------------------------
   zon1    0.         -2.5E-06     1   0.            0.2322
```

In this frame an input part and an output part is shown.

3.6. Flow Components

exam50.cif

One zone with a fan switched half speed at 12:00.

```
&-FA       FAN                     7
*FA1
  ____________________________________________________________
 |1.|# Flag: 1=use Polynomial C0,..C5                          |
 |__|        2=use Data pairs to calculate C0,..Cni            |
 | ____________________________________________________________|
 | Flag|Exp Polynom.|RhoI    | NfI    |   Cs          | Exp n  |
 |(-)  |(-)         |(kg/m3) |[rpm]   |[kg/s@1Pa]     |[-]     |
 |_____|____________|________|________|_______________|________|
1        2           1.2      2800    0.001          0.55
  ____________________________________________
 |2.| Pmin   |  Pmax    |Slope      | Intercept |
 |__| (Pa)   |  (Pa)    |(m3/s/Pa)  |(m3/s)     |
 |__________|__________|__________|___________|
    0          100        -0.00042    0.042
  _________________________________________________________________
 |3.|C0      |C1         |C2         |C3          |C4         |C5        |
 |__|(m3/s)  |[m3/s/Pa]  |[../Pa2 ]  |[../Pa3  ]  |[../Pa4 ]  |[../Pa5]  |
 |__________|__________|__________|___________|__________|_________|
  0.042       -0.00021   -2.1E-6
&-NET-LINks                      22
  _____________________________________  _____________________________
 |Link|Type | Zone No |  Height  | Own   |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|       |    |  or  |_____________________|
 |    |     |    |    |    |    |       |    |      |T-Junct.  Ref.Link   |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |   No    |   Angle    |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |   [-]   |   [deg]    |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 door   CR1  -cp1  zon1  1.1 1.1   d     16
 fan    FA1  zon1 -cp2   1.5 1.5   d     2800   d     FA1

&-SCH-FAN schedules              26        --- OPTIONAL DATASECTION ---
  ________________________________________________________
 |Schedule    |     Time              |      Fan Speed        |
 |*Name       |                       |        Factor         |
 | (-)        |     (-)               |         (-)           |
 |____________|______________________|______________________|
*FA1              12:00                        0.5
```

If the fan had to be switched again after 12:00, add a line with only the new time and the speed factor, i.e. : 13:00 1.0

exam51.cif

One zone with a TD (Test Data) component.

exam52.cif

One zone with a TD (Test Data) component as a constant flowrate device. This is an important example for use at constant or fixed mechanical flowrates. The advantage of the use of a simple TD component for this is that the pollutant routines 'know' where the flow is coming from, and thus what concentration it entrains.

```
*TD1
  ________________________________
 |1.|Flag Fva or Fma | RhoI       |
 |__|     (1 or   2) |[kg/m3]     |
 |___________________|____________|
   2                   1.2
  __________________________________________________________________________
 |2.| Pressure and Flowrate, maximum  6 Lines                                |
 |__| Data Pairs: minimum 3 Pairs, maximum 18 Pairs                          |
 | (Pa)       | (m3/s)    | (Pa)      | (m3/s)    | (Pa)      | (m3/s)     |
 |____________|___________|___________|___________|___________|____________|
    0.0          0.05
&-NET-LINks                       22
  ______________________________________ __________________________________
 |Link|Type | Zone No |  Height | Own   |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|       |    |  or  |_____________________|
 |    |     |    |    |    |    |       |    |      |T-Junct.  Ref.Link   |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |   No    |   Angle   |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |   [-]   |   [deg]   |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 door   CR1  -cp1  zon1  1.1 1.1   d     40
 td     TD1   zon1 -cp2  1.5 1.5
```

exam53.cif

Flowcontroller F1.

exam54.cif

Flowcontroller F2.

```
&-F2       FLOWCONTROLLER IDEAL NONSYMETRIC          11
*F21
  _______________________________________________________
 |1.|#Range1                                             |
 |__|____________________________________________________|
 | Flowcontroller curve , Maximum 1 line (2 pairs)       |
 |  Data pairs: Pression rise, Flowrate                  |
 |     (Pa)     |    (kg/s)    |     (Pa)     |    (kg/s)    |
 |_____________|_____________|_____________|_____________|
     0               0             10          0.007


  _________________________________________
 |2.|#Range2                               |
 |__|_______________________________________|
 |Fva_Setpoint | Fva_setpoint negative flow |
 |(m3/s)       | (m3/s)                     |
 |_____________|____________________________|
    0.007          0.014

a small part of the ouput a various wind speeds:

meteo flow through F2
m/s     kg/s
 1    3.255E-04
 4    6.169E-03
40    7.   E-03
```

In the frame a part from the input and some output figures have been moved in.

At 4 m/s wind speed the controller almost reaches it's setpoint of stabilization. At 40 m/s the flowrate clips to 0.007 .

Flow controllers F3 and F4 are not included because EMPA is working on the Flow controllers which will alter the way to use F3 and F4

exam57.cif

The use of a Related Flow device RF. The flowrate through this component is a function of a the flowrate in a 'reference' link. Both the function and the reference link are given in the input file.

exam58.cif

The use of a Related Flow device RF to simulate a kitchen hood. The primary effect of this 'Hood' is the implicit simulation of the hood efficiency to capture and remove pollutants produced in the range under the hood, which is simulated as a small zone in the kitchen. This applies for kitchens but also industrial configurations.

```
&-RF       Related Flow COMPONENT
*RF1 name
  ______________________________
 |1.|Flag Fva or Fma | RhoI      |
 |__|(1 or 2)        |[kg/m3     |
 |___________________|___________|
    2                  1.2
  ______________________________________________________________________
 |2.| Pressure and Flowrate     maximum  6 lines                        |
 |__| Data pairs     minimum 3 pairs ,     maximum 18 pairs             |
 | (refm3/s)  | (m3/s)    | (refm3/s) | (m3/s)    | (refm3/s) |   (m3/s)  |
 |____________|___________|___________|___________|___________|___________|
   -0.1  0.2  0.02  0.2   0.045 0   0.4   0

&-NET-LINks                       22
  ____________________________________ _________________________________
 |Link|Type | Zone No |  Height | Own  |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|      |    |  or  |_____________________|
 |    |     |    |    |    |    |      |    |      |T-Junct.  Ref.Link   |
 | No |Name |From|To  |From|To  |Height|Val.|Press |   No    |   Angle   |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |   [-]   |   [deg]   |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 L1     CR1    -1    kit 1.1  1.1
 L2     CR2    kit   hoo 1.5  1.5
 L3     FA1    kit   -2   3    3      d   1000   d      FA1
 L4     TD1    hoo   kit 2.5  2.5    d     1    d
 L5     RF1    kit   hoo 2.5  2.5    d     d    d      L3
```

The hood efficiency would be the result of the ratio between the RF flowrate and the fan flowrate (used as reference).

3.7. Output

exam60.cif

The use of Simulation and Output options, together with COMIS.Set

If there is no start and stop time given and no ventilation output option, then COMIS uses 2Vent as default.

exam61.cif

The use of Simulation and Output options, together with COMIS.Set and Debug3 as output option.

In the output follows an overview of the contents of all events in de TMS file (Time Management System) and the data retrieved from COMIS.CIF that has been stored in the direct access file COMIS.DAF. This is only useful of one suspects some error in the input or the program.

Output of COMIS is largely controlled by the COMIS.set file, except for the simulation and output options given in de input file COMIS.cif .

The settings file 'COMIS.set' contains first 5 numbers that control the amount of output and echo from the program. Output echo is used mainly for bug finding and are more and more replaced by options at &-PR-SIMU and &-PR-OUTPut .

There are 5 parameters that control the amount of echo:

```
                    Test  (master switch for extra output)
                    iEcho (input echo)
                    pEcho (precalculations echo)
                    sEcho (ventilation pressure solver echo)
                    oEcho (output echo)
```

The next levels have been used in the program

```
Test    >=1

Iecho   >= 1, 2, 3, 4, 5, 6, 7, 8, 9
Pecho   >= 1, 2
Secho   >= 1, 2, 3, 4, 5, 6, 7, 8, 9, (>=2 <4)
Oecho   >= 1, 2, 3, 4
```

```
Test    0 disable all extra echo
        1 report which
          part of the
          program runs i.e.:
          report number of items seen in the input, i.e.:
```

```
                              Ntyp  .  .  .   N AFC components =          1
                              Nz                       N Zones =          1
                              Nl .  .  .  .  .  .  .   N Links =          2
                              Nwind            N windpressures =          2
                              Nspec .  .  .  N fixed pressures =          0
                              Nzl      no of zones with layers =          0
                              Nzp  no of zones with poll input =          0
                              MLayDat     N dataelementsLayDat =          9
                              Nconc .  Number of possible conc =          0
                              MLDat         N elements in Ldat =         11
                              NCpDir   .  N Wind Cp directions =          4
                              MEnvDir   N ENVironm. DIRections =          3
```

report what the program did:

```
                              *******************************
                              Reading Input File            *
                              *******************************


Iecho   >= 1,2,3,4,5,6,7,8,9
           | | | | | | | | |
           | | | | | | | | | string and position of words read
           | | | | | | | | schedule defined
           | | | | | | | Occupant in zone
           | | | | | | Wall material
           | | | | | keywords
           | | | | linkstatus, tree's, PR-CONT, Ldat, From-To, Zones,poll. Walldata
           | | occupant
           | CapCom files read
           program part(same as Test only), pollutant names



pEcho   >= 1,2
           | |
           | Rho,Visc,Meteo,Cp,DpStack,DPLink,Concentrations,Large Openings,LinkStatus
           end of precalculations

sEcho   >= 1,2,3,4,5,6,7,8
           | | | | | | | |
           | | | | | | | | total flow per zone
           | | | | | | data, Rho etc per link
           | | | | | mass flow and derivative per link
           | | | | diagonal
           | | | Dp, FmaI for solver 0
           | | linear solution (as start vector)
           | 3 point optimum for solver 0
           Flow balance progress

if test=0 (test=1 switches most output on regardless of oEcho)
oEcho   >= 1,2,3,4
           | | | |
           | | | Fma and DFma on screen
           | | Vent:Fma DFma,Dp,link, From-to
           | 2Vent:Link and zone flows
           2Vent:only total and room groups
```

exam62.cif

This is example exam09.cif but then with User-Unit pressure Pa-OSR as output option. The effect is that the pressures refer to the outside pressure at zone reference height. Hereby the pressure hierarchy is reflected in a better way. It looks as if the whole building is made 'flat' and no height differences obscure the zone pressures, while the simulation is done with all driving forces due to height and temperature differences. Still for the exact value of the pressure difference at a link one has to look and the link part in the output. This is because the build up of stack pressure remains for a part in the height traject between the zone reference heigth and the vertical position of the link. In essence these stack pressures will differ between zones.

Zone-ID	pressure Pa-OSR	totalflow kg/s	infiltration kg/s	ventilation kg/s	imbalance kg/s	temperature C
zon1	0.632	0.1997	0.1997	0.	1.605E-12	20.

3.8. Spreadsheet and Histogram output

exam70.cif

This is a kitchen (zone 1) ventilatied with 7 dm3/s from 10:00 to 15:00.

An occupant stays in the kitchen. The occupant is outdoors between 11:00 and 11:30.

The coarse of CO2 is traced in a CSO spreadsheet file and a Histogram. From the CO2 concentration an effective flowrate (based on pollutant 1) is calculated.

exam71.cif

This is the kitchen from example 70, now with an added livingroom. The occupant moves from room to room and produces CO2. Spreadsheet files and Histograms are filled for the occupant and the zones.

In this example CO2 has been defined as pollutant 1.

```
&-POL-DEScription                   37          --- OPTIONAL DATASECTION ---
  _________________________________________________________
 | NR  |NAME                 |MOLAR MASS|Diffusion|Conc   |
 |[-]  |[-]                  |[gr]      | [m2/s]  |Limit  |
 |     |                     |          |         |[kg/kg]|
 |     |                     |          |         |       |
 |_____|_____________________|__________|_________|_______|
   1    CO2                    44        2E-5    9.12E-4
; 9.12E-4 kg/kg leads to about 600 ppm

  _Fictive  sources__in kg/s...__Effective flowrates
 |-------------Room----------- |-Occupant-|
 | fixed | floor | wall  |volume | fixed     |
 |       |  /m2  |  /m2  |  /m3  |OccuDep    |
 | RoomDep:      |       |       |           |
 |   0   |   1   |   2   |   3   | 0..3      |
 |_______|_______|_______|_______|___________|
& 7.6607E-6 5.5E-7 1.44E-7 2.1E-7  7.6607E-6
```

The option :

C1-S kit,liv,occ1

generates a C1xy.CSO file for pollutant 1, CO_2, which has been plotted in figure 1

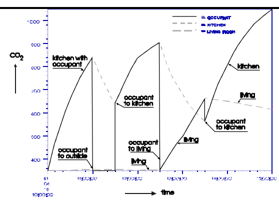


Figure 1: CO2 coarse of exam71 via CSO file to a graphics program.

The occupant is scheduled to start in the kitchen, goes outdoors at 11:00 and enter the kitchen again at 11:30 . At 12:30 the occupant goes to the livingroom and returns to the kitchen at 13:30.

Every hour there is a change in the meteo conditions. This is most obvious at 12:00 where the wind speed increases and at 13:00 where the wind direction changes.

```
&-SCH-OCCupant schedules        31            --- OPTIONAL DATASECTION ---
  ___________________________________________________________________
 |SCHEDULE | TIME              |ZONE     |ACTIVITY LEVEL |Number of |
 |*NAME    |                   |NR       |FACTOR  (-)    |occupants |
 |[-]      |[-]                |[-]      |[-]            |[-]       |
 |_________|___________________|_________|_______________|__________|
*OCC1               10:00:00     1        1.4            1
; 11:00 to outdoors
                    11:00:00     1        0.0            0
                    11:30:00     1        1.4            1
                    12:30:00     1        0.0            0
; 12:30 to living
                    12:30:00     2        1.2            1
                    13:30:00     2        0.0            0
; 13:30 to kitchen
                    13:30:00     1        1.4            1
```

In this simulation the CO2 is produced by the occupant. The definition of the occupant is done by:

```
&-OCCUPANt description                39        --- OPTIONAL DATASECTION ---
#------------
#  OCCUPANTS
#------------
# on the continuation line: (0..5)x(pollutant and source strength) can be given
  ________________________________________________________________
 |NR  |SEX   |AGE  |LENGHT |MASS |ACTIVITY|CIGARETS  |name       |
 |[-] |[-]   |[a]  |[m]    |[kg] |[W/m2]  |[1/s]     |[-]        |
 |____|______|_____|_______|_____|________|__________|___________|
   1   MALE   d     d       d       d       0          man
& CO2   d   O2    d
```

In the input the 'd' forces COMIS to use its default variables or functions. The default age is 20 and Length, Mass and Basal CO2 production are calculated by internal functions. Of course it would be easy to input an age. The CO2 production is a function that includes several aspects among which is the (scheduled) occupant activity.

The inaccuracy of these functions is 6% (max) for a group of persons (Dutch data). There will be obvious differences for different parts of the world, i.e. the function of the average length of a group of persons with age will vary from place to place. But if there is data on length etc, it will be simple to enter that in the input.

This opens interesting possibilities to do very accurate research for buildings with a large number of occupants (shops, theatres, sport halls, office buildings, etc).

Comparison of measured and simulated CO2 levels would yield information on the flowrates in the real building.

The histogram has been defined by:

```
&-HISTO defines ranges for histograms
  ________________________________________________________
 |Histo|Number |  Lower   |  Upper   | Room size | occupant  |
 |gram |Classes|  Class   |  Class   | dependency| dependency|
 |_____|_______|__________|__________|___________|___________|
    1     11     0            20        0            0
    2     10     300        1200        0            0
    3     16     0            10        0            0
```

Here only a few classes have been defided but histograms with much more classes are possible. There is a total space for 5000 classes (i.e. 50 histogram columns of 100-11 (11=overhead) classes each). The 11 overhead data per histogram (column) are used for minimum, maximum, average, etc.

Histogram 2 has been invoked by:

C1-H2 kit,liv,occ1

The start time of filling the Histogram has been chosen some what later that the start of the simulation:

```
                 STARTtime 1991jun15_10:00
                 HISTO     1991jun15_10:20
                  STOPtime 1991jun15_15:00
```

At 20 minutes past 10:00 the histogram starts. This can be used to get a preconditioning time and to avoid erratic start values that otherwise would foul the minimum/maximum/over range or average calculation.

This Histogram 2 looks like:

```
Histogram 2  10 Classes From   300.00000 To  1200.00000 width=   100.00000
 Room dependency=   0 Occupant dependency=   0
  ClassCenter      C1-kit      C1-liv      C1-occ1
                   ppm         ppm         ppm
    300.00000     0.0         0.0         0.0
    400.00000     0.0         0.53405     0.17921
    500.00000     0.0         0.07168     0.07168
    600.00000     0.15771     0.26882     0.13620
    700.00000     0.27240     0.12545     0.15412
    800.00000     0.27599     0.0         0.18638
    900.00000     0.17921     0.0         0.15771
   1000.00000     0.11470     0.0         0.11470
   1100.00000     0.0         0.0         0.0
   1200.00000     0.0         0.0         0.0
  below_range     0.0         0.0         0.0
  over__range     0.0         0.0         0.0
  max_freq        0.27599     0.53405     0.18638
  average       782.01044   477.41022   697.31952
  total_time      16740.0     16740.0     16740.0
  minimum       562.89355   350.62796   350.00964
  maximum      1047.54175   663.33691  1047.54175
  excess_vals   182.92528    14.19457   146.90262
  Limit         600.35510   600.35510   600.35510
  Unit_offset     0.0         0.0         0.0
  Unit_mult.   6.5828E+05  6.5828E+05  6.5828E+05
```

The outside CO2 concentration is 350 ppm and falls in the class with center 400. The effective flowrate has been placed in Histogram 1 by:

EF-H1 kit,liv,occ1

Histogram 1 is:

```
Histogram 1  11 Classes From     0.00000 To    20.00000 width=     2.00000
 Room dependency=   0 Occupant dependency=   0
  ClassCenter      EF-kit      EF-liv      EF-occ1
                   dm3/s       dm3/s       dm3/s
      0.0         0.0         0.0         0.0
      2.00000     0.0         0.0         0.0
      4.00000     0.0         0.0         0.0
      6.00000     0.11470     0.0         0.11470
      8.00000     0.26882     0.0         0.22222
     10.00000     0.23298     0.0         0.15054
     12.00000     0.16487     0.0         0.08602
     14.00000     0.10036     0.24373     0.07168
     16.00000     0.05735     0.11828     0.05018
     18.00000     0.04660     0.01792     0.03226
     20.00000     0.01434     0.01434     0.02151
  below_range     0.0         0.0         0.0
  over__range     0.0         0.60574     0.25090
  max_freq        0.26882     0.24373     0.22222
  average        10.61413   949.01862  1.0753E+35
  total_time      16740.0     16740.0     16740.0
  minimum         6.02473    13.41229     6.02473
  maximum        19.74125  6809.63721  1.0000E+36
  excess_vals     0.06402     0.0         0.06402
  Limit           6.99991     6.99991     6.99991
  Unit_offset     0.0         0.0         0.0
  Unit_mult.    833.33331   833.33331   833.33331
```

Effective flowrates in histograms have proven to be very useful in analyzing building ventilation. If there are no excess values (sum of time-duration multiplied with the excess value with respect of the given limit) then the average is a single and good indicator for the quality of the situation. With such a single number the performance of a complete building together with it's operation, weather, etc can be judged. Buildings or variations in the design or ventlation system can be compared.

This is much more efficient than an evaluation of all flowrates, and is still very accurate.

exam80.cif

This is a kitchen (zone 1) and an cooking range (zone 2). The ineffectiveness of the hood (link L3, a FAn) is simulated by the new RF (Related Flow) component (link L4). The flow of this RF is related to the fan flow, and pictures a hood efficiency which is a function of the fan flow rate. Link L3 is the supply opening from kitchen to the kitchen hood. L1 is the door of the kitchen to outside.

At &NET-LINks the name of the reference link is given (here L3 the fan). The implicit hood efficiency is given at the RF definition. This is example HOOD 4.

exam81.cif

This is a kitchen (zone 1) ventilated with 7 dm3/s and an occupant stays in the kitchen. The histograms are started 30 minutes after the simulation start.

exam82.cif

This is a kitchen (zone 1) and an cooking range (zone 2). In addition to example 80 here the histograms start after one hour. This filters out the first time where concentrations are zero and hence effective flows are infinite. Minima and maxima in the histogram now make more sense.

4. LITERATURE

[1] Technical Note AIVC 29. Fundamentals of the Multi zone Air Flow Model- COMIS. AIVC Coventry, GB. May 1990.

[2] COMIS User Guide . LBL, Berkeley USA. (currently being updated).

[3] Phaff, J.C. Collecton of Annex 23 Papers. Multi zone air flow models. TNO Building and Construction research. report 94-BBI-R0168. Delft, 1994 november.

Enclosure 1. Glossary of terms.

;	Comment indicator in COMIS.CIF and some parts of COMIS.SET.
#	Comment indicator in COMIS.CIF and some parts of COMIS.SET.
&	Continuation line in COMIS.CIF only for occupant and pollutant definition. There is a space ater the '& '
&-	Keyword indicator in COMIS.CIF.
&-NET-LINks	Keyword for the start of the section where the network links are defined.
&-NET-ZONes	Keyword for the start of the section where the zones (internal nodes) are defined.
&-PR-CONTrol	Keyword for the start of the section where the solver control is defined.
&-PR-SIMUlation	Keyword for the start of the section where the simulation and or output options are defined.
A23	Annex 23.
A27	Annex 27.
AFC	Air Flow Component, a link: Crack, Fan, Window, Duct, etc.
Air Flow Component	AFC, a link: Crack, Fan, Window, Duct, etc.
basal metabolism	Metabolism (heat released by a (human) being) at the lowest activity (factor 1.0) at sleep.
building ventilation	Air flow rates through a building to keep the indoor air of sufficient quality.
C-value	Conductance for airflow of a crack (AFC) expressed as kg(air)/s at a pressure difference over the crack of 1 Pa. (COMIS can convert other units like: ELA4, ELA10, etc).
CER	COMIS ERror file.
CIF	COMIS Input File.
coefficient	See: pressure coefficient.
COF	COMIS Output File.
COMERL	Shell program to control COMIS made by EMPA (CH).
COMIS	Conjunction Of Multi zone Infiltration Specialists. A one year workshop held at LBL Berkeley USA from 1988 to 1989, in which an early version of COMIS was created.
COMIS.CER	COMIS ERror file.

COMIS.CIF	COMIS Input File.
COMIS.COF	COMIS Output File.
COMIS.DAF	COMIS Direct Access File (contains data from CIF that has to be used more than once).
COMIS.TMS	COMIS Time Management File. (this file can have the name COMIS.TMS or COMIS2.TMS and is normally deleted after COMIS ends).
computer model	Simulation program, here to simulate building ventilation.
computer program	Simulation program, here to simulate building ventilation.
COMIS	COMIS VENtilation program. It is the 'engine' of the programs in the COMIS group. It's main task is to calculate pressures and flowrates in buildings and to calculate the coarse of pollutant concentrations.
conductance	Conductance for airflow of a crack (AFC) expressed as kg(air)/s at a pressure difference over the crack of 1 Pa. (COMIS can convert for other units like: ELA4, ELA10, etc).
cp	Coefficient of (wind) pressure. This coefficient is used to calculate the wind pressure at a certain wind speed from the dynamic pressure of the wind speed. The coefficient has different values over the facades and has is a complex function of the wind direction. The reference wind speed is usually speed at roof height. Some times the coefficients are made for use of the wind speed at the meteo station.
CR	Indicator to be used for Air Flow Components that define a Crack.
crack	Crack, (small) opening in a wall or construction. The formula for the airflow through a crack is also used for larger openings. For openings in which a two way flow can occur it is better to use the WI (window) AFC type.
Cs	Specific C-value. depending on what is input at &-AFC and &-NET-LINk this can be the C-value per m² wall area or per m crack length.
CSO	COMIS Spread sheet Output.
DAF	Direct Access File.
date	COMIS uses YYmmmdd_ i.e. 1996jan01_ but 19960101_ or jan01_ is also interpreted. The User Guide explains the full range of possible date_time formats.
door	Doors might be simulated with the AFC type WI if they

have to be opened.

dosis	Dosis can be used in COMIS as the average concentration inhaled by an occupant, given by a histogram. The term dosis deviates here from the common meaning, in that there is no biological absorption coefficient taken into account, and that only aerosol, inhaled substances are simulated.
Dubois area	Surface area of a person.
effective flowrate	Part of the ventilation flow that is still clean air (concentration is lower than the limit for pollutant 1).
event	Value in a schedule at a given time. Depending on the type of schedule and where it is used, one or more variables, that normally are assigned at first from the input file, will get an altered value as from this moment.
ExpN	Flow exponent (0.5=turbulent 1.0=laminar) used mainly for the crack flow equation.
external node	Outside point, wind pressure, cp-point, facade element.
f:	Indicator to use the next word as a filename to read data from.
F1	Flow controller.
F2	Flow controller.
FA	Fan.
facade element number	Numbered part on a facade to which a cp-value is assigned to be able to calculate the wind pressure. Facade element numbers are just a way to uncouple the ID's of external nodes and the ID's of cp's. This allows to use an existing table of Cp coefficients with an existing COMIS.CIF where a Network of links has already a set of ID's for the external nodes. A translation table at &-NET-EXTern defines which facade element number and thus which Cp will be used for an external node.
fan	Fan. Flowrate as a polynomial function of the pressure difference across the fan. Fan laws for changes in fan speed and air density are used.
flow controller	AFC that has an active or passive control of the flowrate as a function of the pressure. The simplest type keeps the flowrate constant above a certain pressure difference.
From	The node at the 'From' side of a link. If the actual flow direction is in the 'from->to' direction it is

output positive. Reverse flows are output as negative when output option 2VENT is used. Output option VENT gives the flowrates in two columns, the first column is for flows in the 'From->To' direction, the second column for the reverse direction (the value is printed as a positive number).

GetLDat Routine in COMIS that reads Link Data from the input file.

GetW. Series of routines, GetWS, GetWI, GetWR, in COMIS that read strings, integers and reals.

histogram Option in COMIS to place variables in histograms in the output file. The same variables that can be used for CSO files can go into a histogram. There is space for 5000 histogram classes i.e. (100-11) classes * 50 histogram columns. 11 is the overhead per histogram column.

hood efficiency Efficiency for removal of pollutants generated under the hood. In COMIS this efficiency is a function of the ratio between the flowrate in the RF link and the Fan in the hood.

HVAC Duct system for air conditioning. Besides fans and grilles or orifices (simulated by CR AFC) COMIS can simulate ducts and T-junctions. Improvements for T-junctions are being made by EMPA.

IISiBAT CSTB intelligent building simulation shell, which has been coupled with COMIS. It provides a graphical interactive method to build the input, to call COMIS and to analyze the output.

IntCon Routine in COMIS the constructs an integer from a line of characters.

interval Time span between two successive timesteps of COMIS. Timesteps are always positioned at events from the schedules in COMIS.

keyword Word in the input file that starts with '&-' and has 7 significant letters.

keyword section After a keyword is a section that stops at the next keyword or end of file. It contains data for a certain aspect in COMIS i.e. Zones or Links, etc.

kitchen hood Exhaust hood often found above cooking ranges in dwellings. In COMIS it consists of a small zone, the space between the cooking range and the hood, a RF AFC type in the interface between the kitchen and the hood space and an exhaust that might contain a fan in the hood or a duct system that leads to a central fan. A hood may also be simulated with a Large Opening instead of the RF component.

link Air flow path between two nodes (zones or external nodes). The link will have an AFC type, a crack (CR) , large opening (WI), etc.

metabolism Heat released by a (human) being.

model Word mainly used for the computer simulation program for building ventilation.

molar mass The molar mass (mass of one mol of a substance (gas)) is used in COMIS to make unit conversions.

MULTI ZONE VENTILATION

MODEL Computer simulation program for building ventilation. Multi zone means that the model can handle more tan one zone and does simulate inter zonal flowrates. COMIS can handle a few hundred of zones. A zone can be one room in a building, but also a group of rooms. An zone in COMIS could even be just a part of an actual room.

network Set of links, zones and external nodes. This network may reflect the air flow paths in a real building.

node Junction of links in the network. In most cases this is a room in a building, but it could be a gap in a construction (cavity wall) or a series of rooms that have open internal doors and are combined into one zone in COMIS to ease the modelling in case the inter room flowrates are not of main importance.

occupant Person that may be moved through the zones of a building to produce or 'sample' pollutants (stored as concentration in histograms).

OSR Pressure with OutSide as Reference. If the output unit for pressure 'Pa-OSR' is used COMIS outputs zone pressures with as reference the outside pressure at the reference level of the zone. This reference level is given at &-NET-ZONes. This is a better approach to reflect the pressure hierarchy of the zones. Still the exact value of the pressure across a link can only be seen at the link part in the output.

outside pressure profile The outside pressure profile with height, follows the barometric profile and decreases about 12 Pa per meter at sea level. Taken into account is the outside temperature given at the meteo schedule and the meteo barometric pressure.

Pa-OSR Pressure with OutSide as Reference. Output zone pressures with as reference the outside pressure at the reference level of the zone. This reference level is given at &-NET-ZONes.

period	Simulation period. Time span between start time and stop time given at &-PR-SIMUlation.
pressure	Air pressure. Except for the barometric pressure at the meteo schedule COMIS outputs only the pressure difference between the outdoor pressure (at building entrance level or zone reference level (Pa-OSR)) and the pressure per zone (at reference level).
pressure solver	Heart of COMIS that iteratively approximates the air pressures in the zones of a building (network).
progress	% of the complete simulation period covered so far during a simulation. It may be displayed on screen by using the 'OnScreen Progress' option at &-PR-SIMUlation.
PS	Passive stack, a duct for natural ventilation with at the roof side a cowl with a wind suction effect simulated by an extra wind pressure coefficient that is a function of the wind velocity and the air velocity through the duct.
pressure coefficient	Ratio between the wind pressure at a facade (or roof) and the dynamical pressure of the reference wind speed.
RelCon	Routine in COMIS that constructs a Real from a line of Characters.
RF	Related Flow AFC type. The flow through this RF component is a given function of the flowrate through another link.
room	Room in a building that may be represented by a node in the network.
schedule	Series of events for a certain parameter, every event consists of a time and one or more data. Every schedule starts with an ID by which it can be used for zones or links. This ID starts with an '*' at the schedule definition.
simulation period	Time span between start time and stop time given at &-PR-SIMUlation.
sink	Area or place where pollutant is lost. In COMIS a sink is a flowrate of air from which all of the indicated pollutant is deposited. It is removed from the air. This way the deposition rate of a sink is proportional with the concentration, which is close to reality.
solve	Process of iterative approximation of the air pressures in the zones of a building (network).
solver	Heart of COMIS that iteratively approximates the air pressures in the zones of a building (nodes of the

network).

source strength — Mass flowrate of pollutant released in a zone.

source — Pollutant source in a zone.

T-option — T means Total. It results in average values over the total simulation period, printed in table format in the output file, similar to the CSO files.

TD — Test Data AFC. A device which can be given a series of pressure-flowrate points to depict a certain (measured) characteristic of an AFC.

Test Data — TD AFC type. A device which can be given a series of pressure-flowrate points to depict a certain (measured) AFC.

timestep — Moment or event during the simulation. COMIS steps through time from simulation start to simulation stop. At all intermediate scheduled events is a timestep which is always truncated to an integer number of seconds. COMIS can't simulate timesteps that are a fraction of a second.

TMS — Time Management System. This is a direct access file in which all events are sorted and stored. You can output the contents of this file with the DEBUG option at &-PR-SIMUlation.

To — The node at the 'To' side of a link. If the actual flow direction is in the 'from->to' direction it is output positive. Reverse flows are output as negative when output option 2VENT is used. Output option VENT gives the flowrates in two columns, the first column is for flows in the 'From->To' direction, the second column for the reverse direction (the value is printed as a positive number).

User-Units — For many variables in COMIS one can use User-Units in the input file but also in the output file. Explanation is given if you place the option 'UNITS' at &-PR-SIMUlation.

ventilation — The renewal of indoor air by supply of (fresh) outdoor air.

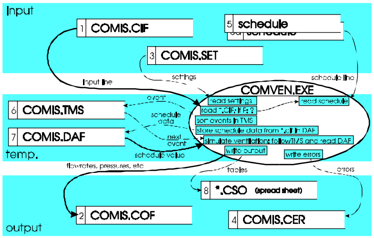
ventilation network — Set of links, zones and external nodes. This network may reflect the air flow paths in a real building.

WDY — Week DaY or Working DaY (MON..FRI). WDY can be used in schedules .

Weekdays/Weekends — Weekdays and weekends can be used in schedules with the words WDY and WND.

Wind pressure	Air pressure on a facade or roof due to the wind.
window	Large opening (AFC WI) that may have a two way flow. In COMIS the windows can be opened by a schedule any fraction between 0..1 . This WI type has to be used for open doors as well.
WND	WeekEnD (SAT, SUN). weekends can be used in schedules.
zone	Often a room in the simulated building. a zone could be a joined group of rooms (with open internal doors) or a room split in a few zones to reflect inter zonal flowrates.

Enclosure 2: Schematic diagram of COMIS



Simplified main flow diagram of COMIS.

The diagram shows the most important files and processes in COMIS. The main input file, nr 1, is COMIS.CIF. There may be a settings file which can define the amount of output and the default filenames for the different programs in COMIS.

If the COMIS.CIF file contains 'F:' before the name of schedules, the name is interpreted as the name of an external schedule file and data is read from that file (nr 5 in the diagram).

COMIS sorts all possible events (time and one or more values) from schedules, including it's own start and stop time in the TMS file (Time Management System). If the Data that belongs to such an event came from *.CIF then it is stored in COMIS.DAF (Direct Access File). Data from (long) external schedule files is not copied this way, but sequentially read during the simulation.

The simulation follows the events in TMS timestep after timestep and reads the new values for variables that change.

Some input may be echoed to the output files. During the simulation output is written to COMIS.COF . Tables for use in spread sheets are created if this is indicated in the COMIS.CIF file.

Errors will be reported in the output file or/and in the COMIS.CER file.

COMIS is a batch program, it has no keyboard input. This makes it possible to call it from other programs.

For long simulations, some output on screen can be selected to follow the progress of the program.

Enclosure 3: Complete input file for example 49.

#exam49.cif

```
&-PR-IDENtification                2
  _______________
 |1.|Problemname |
 |__|            |
 |_______________|
 Two zones, one occupant as source moves from room to room.
 Second 'pollutant' is Oxygen. Ventilation flowrate is about 8 dm3/s.
  _______________
 |2.|Versionname |
 |__|            |
 |_______________|

&-PR-UNITs
massflow  kg/s      m3/s


&-PR-SIMUlation options        3
  _________________________________________________________
 | Output Option Keywords:  One keyword per line only      |
 |                          Keywords may be preceded by NO |
 |_________________________________________________________|
 | VENT:ilation                                            |
 | POL :utant                                              |
 | HEAT:flow                                               |
 | STEADY:State Concentrations Only                        |
 | INPUT   echo                                            |
 | DEFAULT echo                                            |
 | SET     echo                                            |
 | KEYWORD explanation                                     |
 | UNIT    explanation                                     |
 | OnScreen Time Progress Niter TotFlow Error              |
 | START:time<time>[CONT|REUSE]                            |
 | HISTO:time<start time>                                  |
 | SCHED:time<start time>                                  |
 | STOP :time<time>[KEEP]                                  |
 | DEBUG  1..3  ECHO 1=DAF, 2=TMS, 3=DAF+TMS               |
 | CAPSOL 1..2  coupling with the heat-flow program Capsol.|
 |_________________________________________________________|_________________
 | *  Values per zone:            *  Values per windpressure point:          |
 |  PZ = Pressure per Zone         PE = Wind pressure per wind pressure point|
 |  TZ = air Temperature per Zone  IZ = Outdoor air infiltration             |
 |  HZ = Moisture per Zone         AZ = Outdoor air change rate              |
 |  FZ = Flow per Zone             MZ = Room mean age of air                 |
 | *  Values per link:             EZ = Air change efficiency per room       |
 |  FL = mass Flow per Link        IB = Outdoor air infiltration             |
 |  TL = Link Temperature          AB = Outdoor air change rate              |
 |  VL = Actual value             * Building mean age of air                 |
 |                                 FB = Flow Matrix                          |
 | *  Values per Building:         MB = Outdoor air change rate              |
 |  WA = Wind velocity             RB = RMS (t)                              |
 |  TA = Outdoor air temperature   NB = Nominal time constant                |
 |  HA = Outdoor air humidity      EB = Air change efficiency                |
 | *  Values per zone and gas:     LB = Ventilation heat loss energy         |
 |  Cn = Concentration per gas and zone 1<= n <= 5; n = gas number           |
 |  C1 = Concentration for gas 1 etc                                         |
 |  Qn = Pollutant source Strength per gas and zone 1<= n <= 5               |
```

```
 |  Q1 = Pollutant source Strength for gas 1 etc                           |
 |  Sn = Pollutant Sink per gas and zone, 1<= n <= 5                       |
 |  S1 = Pollutant Sink for gas 1 etc                                      |
 | *  Values per occupant:                                                 |
 |  Cn = concentration in the zone the occupant is in                      |
 |  FZ = flow per zone the occupant is in                                  |
 |  EZ = effective flow per zone (the occupant is in) calculated from      |
 |       pollutant 1                                                       |
 |                                                                         |
 | These two letter accronymes must be followed by                         |
 |  -S for spread sheet output separate files                              |
 |  -P for tables       output separate files                              |
 |  -T for average values in a table in *.COF                              |
 |  -H for histogram output in separate files                              |
 |                                                                         |
 | The filenames of the output are composed from the accronym plus the number|
 | plus the text given in COMIS.SET under &-COMIS as:                      |
 | TABLES xy "   "                                                         |
 |                                                                         |
 | Example:                                                                |
 |  C1-S zon1,zon2  ->concentration of pollutant 1 for the zones with      |
 |  the name zon1 and zon2.                                                |
 |  C1-S occ1,occ2  ->concentration of pollutant 1 for occupants 1 and 2.  |
 |_________________________________________________________________________|

 STARTtime  1996may19_23:59
  STOPtime  1996may21_00:00
 2VENT
 POL 2
; DEBUG 3
EchoSCHEDULES
OnScreen Time Progress Niter TotFlow Error

C1-S  zon1

&-CR
*CR1     standard crack
  ________________________________________________________
 |1.|   Cs     |Exp n   | Lenght  |   Wall Properties    |
 |__|          |        |         | Thickness  | U-Value |
 |   (kg/s@1Pa)|  (-)   |  [m]    |    [m]     |[W/m2 K] |
 |_____________|________|_________|____________|_________|
     0.0005       0.5     10.2


&-FA       FAN                    7
*FA1
  ______________________________________________________________
 |1.|# Flag: 1=use Polynomial C0,..C5                           |
 |__|        2=use Data pairs to calculate C0,..Cni             |
 | _____________________________________________________________|
 | Flag|Exp Polynom.|RhoI    | NfI    |   Cs           | Exp n  |
 |(-)  |(-)         |(kg/m3) |[rpm]   |[kg/s@1Pa]      |[-]     |
 |_____|____________|________|________|________________|________|
1        2            1.2      2800    0.001           0.55
  ____________________________________________
 |2.| Pmin  |  Pmax    |Slope     | Intercept |
 |__| (Pa)  |  (Pa)    |(m3/s/Pa) |(m3/s)     |
 |__________|__________|__________|___________|
   0          100        -0.00042    0.042
  ________________________________________________________________
 |3.|C0     |C1        |C2        |C3          |C4        |C5       |
 |__|(m3/s) |[m3/s/Pa] |[../Pa2 ] |[../Pa3  ] |[../Pa4 ] |[../Pa5] |
```

```
 |__________|__________|__________|___________|__________|_________|
  0.042       -0.00021   -2.1E-6

  ______________________________________________________________________
 |4.  |Fan Curve Pressure Rise vs. FlowRate, maximum 4 Lines            |
 |__  | Data Pairs    minimum 3 Pairs,    maximum 12 Pairs              |
 |(Pa)|     (m3/s)     |(Pa)       | (m3/s)     |(Pa)       |(m3/s)     |
 |____|________________|___________|____________|___________|___________|
   0    0

  __________________________________________________________
 |8.|Filter 1   | Filter 2 | Filter 3 | Filter 4 | Filter 5 |
 |__|   (-)     |    [-]   |    [-]   |    [-]   |    [-]   |
 |______________|__________|__________|__________|__________|
   0
```

&-NET-ZONes 18

```
  ______________________________________________________________
 |Zone| Name           | Temp   |Ref.   |Vol   |Abs.   | Schedule |
 | ID |                |        | Height|      | Hum   |  Name    |
 | (-)|[-]             |  [oC]  |  [m]  | [m3] |[gr/kg]| [T./H..] |
 |____|________________|________|_______|______|_______|__________|
 zon1  level1             20.     0      20
```

&-NET-ZP zone-pollutants 20 --- OPTIONAL DATASECTION ---

```
  _________________________________________________________
 |ZONE    |              POLLUTANT                         |
 |        |________________________________________________|
 | *NR    | INITIAL        | SOURCE                | SINK    |
 |        | CONCENTRATION  |                       |         |
 |[-]     |[kg/kg]         |[kg/s]                 |[m/s*m2] |
 |________|________________|_______________________|_________|
*zon1       0.E-6            0.0                    0.0
            0.2325           0.0                    0.0
```

&-NET-LINks 22

```
  _____________________________________ _________________________________
 |Link|Type | Zone No |  Height | Own   |Act.|3Dflow|Schedule Name(5char.)|
 |    |     |_________|_________|       |    |  or  |_____________________|
 |    |     |    |    |    |    |       |    |      |T-Junct.  Ref.Link   |
 | ID |Name |From|To  |From|To  |Height|Val.|Press |   No    |   Angle    |
 |(-) |(-)  |(-) |(-) |[m] |[m] | [m]  |[-] | [Pa] |   [-]   |   [deg]    |
 |____|_____|____|____|____|____|______|____|______|_________|___________|
 door   CR1  -cp1  zon1  1.1 1.1   d     8
 window CR1  zon1 -cp2   1.5 1.5   d     100
 fan    FA1  zon1 -cp2   1.5 1.5   d     680
```

&-NET-EXTernal node data 21 --- OPTIONAL DATASECTION ---

```
  ___________________________________________________________
 |External Node No   | Facade Elem No   | Outside Conc Factor|
 |           (-)     |   (-)            | [-]                |
 |___________________|__________________|____________________|
 cp1                  cp1                  1.0
 cp2                  cp2                  1.0
```

&-SCH-OCCupant schedules 31 --- OPTIONAL DATASECTION ---

```
  ___________________________________________________________________
 |SCHEDULE | TIME                |ZONE     |ACTIVITY LEVEL |Number of |
 |*NAME    |                     |NR       |FACTOR  (-)    |occupants |
 |[-]      |[-]                  |[-]      |[-]            |[-]       |
 |_________|_____________________|_________|_______________|__________|
; occupant is in zone 2
*OCC1              00:00:00     1         1.0              1
; occupant moves out of the building
                   12:30:00     1         0.0              0
```

```
; occupant comes back in zone 1
                   15:30:00     1         1.0             1

&-CP-VALUes                      33        --- OPTIONAL DATASECTION ---
  _________________
 |1.|DATASET NAME  |
 |__|______________|
  ____________________________________________________________________________
 |2.|FACADE|     Wind Direction  (first line )                               |
 |__|ELEMNR|     Cp Values       (second and following lines)                |
 |  * [-]  |[deg] |[deg] |[deg] |[deg] |[deg] |[deg] |[deg] |[deg] |[deg]     |
 |_________|______|______|______|______|______|______|______|______|__________|
*            0      90     120    321
 cp1         0.23   0.45   -0.6   -0.2
 cp2        -0.61  -0.2    0.22   0.46

&-ENV-WINd and meteo related parameters 35  --- OPTIONAL DATASECTION ---
  __________________________________________________________
 |1.|Ref. Height    |  Altitude           | Meteo windvelocity|
 |__|for Wind Speed | Meteo Station       | profile exponent  |
 |    (m)           |  (m)                |  (-)              |
 |__________________|____________________|____________________|
 10.                 3.                   0.14


  ____________________________________________________________
 |2.| Wind      |             |    Wind        |                |
 |__| Direction|Plan Area    |Velocity Profile|  Surrounding   |
 |     Angle    |Density      |    Exponent    |Buildings Height|
 |    (deg)     |   (-)       |     (-)        |     (m)        |
 |______________|_____________|________________|________________|
 0.              0.1          0.22              10.
 270.            0.02         0.14               0.


&-SCH-METeo data                 36        --- OPTIONAL DATASECTION ---
  _________________
 |1.|DATASET NAME  |
 |__|______________|
  ____________________________________________________________________
 |2.|TIME             |       WIND        |TEMPERATURE|HUMIDITY|BAROMETER|
 |__|                 |___________________|           |        |PRESSURE |
 |                    | SPEED  |DIRECTION|           |        |ABSOLUTE |
 |[-]                 |[m/sec] |[deg]    |[oC]       |[gr/kg] |[kPa]    |
 |____________________|________|_________|___________|________|_________|
  1996may19_23:00      10       0          20

&-SCH-POL outdoor concentration data  38    --- OPTIONAL DATASECTION ---
  _________________
 |1.|DATASET NAME  |
 |__|______________|
   outside_pol_Schedule
  ______________________________________________________________________
 |2.| Time      |     Pollutant  Concentration                          |
 |__|           |_______________________________________________________|
 |              |  No1       |  No2       |  No3       |  No4       |  No5       |
 |    (-)       | (kg/kg)    | [kg/kg]    | [kg/kg]    | [kg/kg]    | [kg/kg]    |
 |______________|____________|____________|____________|____________|____________|
1996may19_23:59       0.0    0.2325

&-POL-DEScription                    37          --- OPTIONAL DATASECTION ---
  ________________________________________________________
 | NR  |NAME                 |MOLAR MASS|Diffusion|Conc    |
 |[-]  |[-]                  |[gr]      | [m2/s]  |Limit   |
```

```
 |     |                     |          |         |[kg/kg]|
 |     |                     |          |         |       |
 |_____|_____________________|__________|_________|_______|
   1    CO2                    44        d         3.95E-4
   2    O2                     32        d         2.5E-1

&-OCCUPANt description                39         --- OPTIONAL DATASECTION ---
#------------
#  OCCUPANTS
#------------
# on the continuation line: (0..5)x(pollutant and source strengths) can be given
  ________________________________________________________________
 |NR  |SEX   |AGE  |LENGHT |MASS |ACTIVITY|CIGARETS  |name       |
 |[-] |[-]   |[a]  |[m]    |[kg] |[W/m2]  |[1/s]     |[-]        |
 |____|______|_____|_______|_____|________|__________|___________|
   1   MALE   35      d       d      d      0          man
  _____________________________________________________________
 |polutant   |pollutant  |polutant   |pollutant  |polutant    |
 |ID   source|ID   source|ID   source|ID   source|ID   source|
 |____|______|____|______|____|______|____|______|____|______|
& CO2    d     O2    d
```

Enclosure 5. Complete output file for example 49.

```
COMIS Version: 2.1?tno 1996jul22
 ***CER*** WARNING ***
 CRack:CR1 has  no filter data
 Default no filtering, data has been set to 0.0
 ---------------------------------------------------------------

 THE OUTPUT STARTS HERE!!
 At &-PR-SIMUlation you used: 'EchoSch'. Schedules will report all changes.
 For Occupant: time, schedule name,room nr,Actfactor NrOccupants
 For Meteo   : time, schedule name,Vwind,Dwind,temp,Xh,Pbarom
 For Ext Conc: time, schedule name,pollutant,Facade El,Outside Conc,Conc at Fe.
  time                        schedule name     factor        variable
 SCH3:  1996may19_23:59:00    Sunday      meteo    10.00000     0.0000000E+000   20.00000
0.0000000E+000   101325.0
 SCH0:  1996may19_23:59:00    Sunday HistActive    1.000000        1.000000
 SCH4:  1996may19_23:59:00    Sunday       OCC1  zone=1    1.000000                1
 SCH6:  1996may19_23:59:00    Sunday    SCH-POL  pol=1  Fe=1  0.0000000E+000 0.0000000E+000
 SCH6:  1996may19_23:59:00    Sunday    SCH-POL  pol=1  Fe=2  0.0000000E+000 0.0000000E+000
 SCH6:  1996may19_23:59:00    Sunday    SCH-POL  pol=2  Fe=1   0.2325000      0.2325000
 SCH6:  1996may19_23:59:00    Sunday    SCH-POL  pol=2  Fe=2   0.2325000      0.2325000
 ******************************************************************************
 At time =  1996may19_23:59:00    Sunday  , interval =          60 seconds
 ***CER*** WARNING ***
 Concentrations > 0.025 kg/kg in zone 1 for pollutant 2
 ---------------------------------------------------------------
  NO poltrans    ERRORS REPORTED
  Meteo: Vmeteo=10.m/s Direction0.deg temp=20.C Xh=0. 2-iterations Solver=5
  Vbuilding=8.665m/s
 Cpnr       Cp      Pa windpressure
   1       0.230      10.589
   2      -0.610     -28.083
 Volume flowrates = Mass flowrates/1.2
 -------link------------------------ --from--  ---to---   Tlink  Dp-link    from->to  velocity
 nr    ID        type      Multiplier typ name  typ name    C     Pa           m3/s       m/s
 ----------------------------------------------------------------------------------------
   1 door       CR1            8.E+00 z cp1     z zon1      20.  4.07E+01    2.085E-03      8.206
   2 window     CR1            1.E+02 z zon1    z cp2       20. -2.02E+00   -5.807E-03     -1.829
   3 fan        FA1           6.8E+02 z zon1    z cp2       20. -2.02E+00    7.893E-03         0.
  Zone-ID  pressure totalflow  infiltration ventilation  imbalance temperature
          Pa        m3/s        m3/s        m3/s         m3/s        C
 ------------------------------------------------------------------------------
  zon1     -30.104  0.007893    0.007892    0.          -7.761E-07  20.

 Total infiltration   =  7.8921365E-03 m3/s
 Total air change rate=   1.420585     1/h
 Total building volume=   20.00000     m3

 -Room groups- -----------flow rates--------  ------air change rates-------
  name   volume      inf      vent     total       inf      vent     total
           m3      m3/s      m3/s      m3/s      1/h       1/h       1/h
 zo       20.0       0.0       0.0       0.0       1.4       0.0       1.4
 ==============================================================================

 Pollutant transport output
 ==========================
 Outside concentration kg/kg
  ExtNr    CO2      O2
 convers. 1.E+00  1.E+00
  1       0.E+00  2.33E-01
  2       0.E+00  2.33E-01
```

```
 1996may19_23:59:00    Sunday Pollutant Nr.           1(CO2)
Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
         kg/s       kg/s            kg/s       kg/kg
    1.00        1.00               1.00        1.00
----------------------------------------------------------
  zon1    0.         6.626E-06    1   0.            0.

 1996may19_23:59:00    Sunday Pollutant Nr.           2(O2)
Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
         kg/s       kg/s            kg/s       kg/kg
    1.00        1.00               1.00        1.00
----------------------------------------------------------
  zon1    0.        -5.805E-06   1   0.            0.2325
SCH4:  1996may20_00:00:00    Monday       OCC1  zone=1    1.000000               1
********************************************************************************
At time =  1996may20_00:00:00    Monday  , interval =       45000 seconds
***CER*** WARNING ***
Concentrations > 0.025 kg/kg in zone 1 for pollutant 2
----------------------------------------------------------------
 NO poltrans    ERRORS REPORTED
 Meteo: Vmeteo=10.m/s Direction0.deg temp=20.C Xh=0. 2-iterations Solver=5
 Vbuilding=8.665m/s
Cpnr       Cp      Pa windpressure
  1       0.230      10.589
  2      -0.610     -28.083
Volume flowrates = Mass flowrates/1.2
-------link----------------------- --from--  ---to---   Tlink  Dp-link    from->to  velocity
nr    ID        type      Multiplier typ name  typ name    C     Pa          m3/s      m/s
-----------------------------------------------------------------------------------------
  1 door       CR1            8.E+00 z cp1     e zon1      20.  4.07E+01    2.085E-03      8.206
  2 window     CR1            1.E+02 z zon1    e cp2       20. -2.02E+00   -5.807E-03     -1.829
  3 fan        FA1           6.8E+02 z zon1    e cp2       20. -2.02E+00    7.893E-03         0.
 Zone-ID  pressure totalflow  infiltration ventilation  imbalance temperature
          Pa        m3/s        m3/s        m3/s         m3/s        C
--------------------------------------------------------------------------------
 zon1     -30.104  0.007893    0.007892    0.          -7.957E-07  20.

Total infiltration   =  7.8921821E-03 m3/s
Total air change rate=   1.420593     1/h
Total building volume=   20.00000     m3

-Room groups- -----------flow rates--------  ------air change rates-------
 name   volume      inf      vent     total       inf      vent     total
           m3      m3/s      m3/s      m3/s      1/h       1/h       1/h
zo       20.0       0.0       0.0       0.0       1.4       0.0       1.4
================================================================================

Pollutant transport output
==========================
Outside concentration kg/kg
 ExtNr    CO2      O2
convers. 1.E+00  1.E+00
 1       0.E+00  2.33E-01
 2       0.E+00  2.33E-01

 1996may20_00:00:00    Monday Pollutant Nr.           1(CO2)
Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
         kg/s       kg/s            kg/s       kg/kg
    1.00        1.00               1.00        1.00
----------------------------------------------------------
  zon1    0.         6.626E-06    1   0.            1.953E-05

 1996may20_00:00:00    Monday Pollutant Nr.           2(O2)
```

```
Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
         kg/s       kg/s             kg/s        kg/kg
    1.00        1.00              1.00        1.00
----------------------------------------------------------
  zon1    0.         -5.805E-06   1   0.            0.2325
SCH4:  1996may20_12:30:00    Monday       OCC1  zone=1  0.0000000E+000            0
*******************************************************************************
At time =  1996may20_12:30:00    Monday  , interval =       10800 seconds
***CER*** WARNING ***
Concentrations > 0.025 kg/kg in zone 1 for pollutant 2
----------------------------------------------------------------
 NO poltrans    ERRORS REPORTED
 Meteo: Vmeteo=10.m/s Direction0.deg temp=20.C Xh=0. 3-iterations Solver=5
 Vbuilding=8.665m/s
Cpnr       Cp      Pa windpressure
  1       0.230      10.589
  2      -0.610     -28.083
Volume flowrates = Mass flowrates/1.2
-------link------------------------ --from--  ---to---   Tlink  Dp-link    from->to  velocity
nr    ID        type      Multiplier typ name  typ name    C     Pa           m3/s       m/s
-----------------------------------------------------------------------------------------
  1 door       CR1           8.E+00 z cp1     e zon1      20.  4.07E+01    2.085E-03      8.206
  2 window     CR1           1.E+02 z zon1    e cp2       20. -2.02E+00    -5.81E-03     -1.829
  3 fan        FA1           6.8E+02 z zon1    e cp2      20. -2.02E+00    7.894E-03         0.
 Zone-ID  pressure totalflow  infiltration ventilation  imbalance temperature
          Pa        m3/s        m3/s        m3/s         m3/s        C
-------------------------------------------------------------------------------
 zon1     -30.100  0.007894    0.007895    0.          -1.017E-11  20.

Total infiltration   =  7.8949621E-03 m3/s
Total air change rate=   1.421093     1/h
Total building volume=   20.00000     m3

-Room groups- -----------flow rates--------  ------air change rates-------
 name   volume      inf      vent     total       inf      vent     total
           m3      m3/s      m3/s      m3/s      1/h       1/h       1/h
zo       20.0       0.0       0.0       0.0       1.4       0.0       1.4
===============================================================================

Pollutant transport output
==========================
Outside concentration kg/kg
 ExtNr    CO2      O2
convers. 1.E+00  1.E+00
 1       0.E+00  2.33E-01
 2       0.E+00  2.33E-01

 1996may20_12:30:00    Monday Pollutant Nr.          1(CO2)
Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
         kg/s       kg/s             kg/s        kg/kg
    1.00        1.00              1.00        1.00
----------------------------------------------------------
  zon1    0.         0.           0   0.            0.0008622

 1996may20_12:30:00    Monday Pollutant Nr.          2(O2)
Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
         kg/s       kg/s             kg/s        kg/kg
    1.00        1.00              1.00        1.00
----------------------------------------------------------
  zon1    0.         0.           0   0.            0.2317
SCH4:  1996may20_15:30:00    Monday       OCC1  zone=1    1.000000                1
*******************************************************************************
At time =  1996may20_15:30:00    Monday  , interval =       30600 seconds
```

```
 ***CER*** WARNING ***
 Concentrations > 0.025 kg/kg in zone 1 for pollutant 2
 ----------------------------------------------------------------
  NO poltrans    ERRORS REPORTED
  Meteo: Vmeteo=10.m/s Direction0.deg temp=20.C Xh=0. 2-iterations Solver=5
  Vbuilding=8.665m/s
 Cpnr       Cp      Pa windpressure
   1       0.230      10.589
   2      -0.610     -28.083
 Volume flowrates = Mass flowrates/1.2
 -------link----------------------- --from--  ---to---   Tlink  Dp-link    from->to  velocity
 nr    ID        type      Multiplier typ name  typ name    C     Pa          m3/s      m/s
 -----------------------------------------------------------------------------------------
   1 door       CR1           8.E+00 z cp1     e zon1      20.  4.07E+01    2.085E-03      8.206
   2 window     CR1           1.E+02 z zon1    e cp2       20. -2.02E+00   -5.807E-03     -1.829
   3 fan        FA1          6.8E+02 z zon1    e cp2       20. -2.02E+00    7.893E-03         0.
  Zone-ID  pressure totalflow  infiltration ventilation  imbalance temperature
           Pa        m3/s        m3/s        m3/s         m3/s        C
 -------------------------------------------------------------------------------
  zon1     -30.104  0.007893    0.007892    0.          -7.922E-07  20.

 Total infiltration   =  7.8921746E-03 m3/s
 Total air change rate=   1.420591     1/h
 Total building volume=   20.00000     m3

 -Room groups- -----------flow rates--------  ------air change rates-------
  name   volume      inf      vent     total       inf      vent     total
            m3      m3/s      m3/s      m3/s      1/h       1/h       1/h
 zo       20.0       0.0       0.0       0.0       1.4       0.0       1.4
 ===============================================================================

 Pollutant transport output
 ==========================
 Outside concentration kg/kg
  ExtNr    CO2      O2
 convers. 1.E+00  1.E+00
  1       0.E+00  2.33E-01
  2       0.E+00  2.33E-01

  1996may20_15:30:00    Monday Pollutant Nr.           1(CO2)
 Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
          kg/s      kg/s             kg/s       kg/kg
    1.00        1.00              1.00        1.00
 ----------------------------------------------------------
   zon1    0.         6.626E-06    1   0.           1.622E-05

  1996may20_15:30:00    Monday Pollutant Nr.           2(O2)
 Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
          kg/s      kg/s             kg/s       kg/kg
    1.00        1.00              1.00        1.00
 ----------------------------------------------------------
   zon1    0.         -5.805E-06   1   0.           0.2325
 SCH4:  1996may21_00:00:00   Tuesday       OCC1  zone=1    1.000000               1
 *******************************************************************************
 At time =  1996may21_00:00:00   Tuesday  , interval =           0 seconds
 ***CER*** WARNING ***
 Concentrations > 0.025 kg/kg in zone 1 for pollutant 2
 ----------------------------------------------------------------
  NO poltrans    ERRORS REPORTED
  Meteo: Vmeteo=10.m/s Direction0.deg temp=20.C Xh=0. 3-iterations Solver=5
  Vbuilding=8.665m/s
 Cpnr       Cp      Pa windpressure
   1       0.230      10.589
```

```
  2      -0.610     -28.083
 Volume flowrates = Mass flowrates/1.2
 -------link----------------------- --from--  ---to---   Tlink  Dp-link    from->to  velocity
 nr    ID        type      Multiplier typ name  typ name    C     Pa          m3/s       m/s
 -------------------------------------------------------------------------------------------
   1 door       CR1           8.E+00 z cp1     e zon1      20.  4.07E+01    2.085E-03      8.206
   2 window     CR1           1.E+02 z zon1    e cp2       20. -2.02E+00    -5.81E-03     -1.829
   3 fan        FA1          6.8E+02 z zon1    e cp2       20. -2.02E+00    7.894E-03         0.
  Zone-ID  pressure totalflow  infiltration ventilation  imbalance temperature
           Pa        m3/s        m3/s        m3/s         m3/s        C
 -------------------------------------------------------------------------------
  zon1     -30.100  0.007894    0.007895    0.          -1.017E-11  20.

 Total infiltration   =  7.8949621E-03 m3/s
 Total air change rate=   1.421093     1/h
 Total building volume=   20.00000     m3

 -Room groups- -----------flow rates--------  ------air change rates-------
  name   volume      inf      vent     total       inf      vent     total
            m3      m3/s      m3/s      m3/s      1/h      1/h      1/h
 zo       20.0       0.0       0.0       0.0       1.4       0.0       1.4
 ===============================================================================

 Pollutant transport output
 ==========================
 Outside concentration kg/kg
  ExtNr    CO2      O2
 convers. 1.E+00  1.E+00
  1       0.E+00  2.33E-01
  2       0.E+00  2.33E-01

  1996may21_00:00:00   Tuesday Pollutant Nr.          1(CO2)
 Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
          kg/s       kg/s             kg/s       kg/kg
     1.00        1.00              1.00        1.00
 ----------------------------------------------------------
   zon1    0.         6.626E-06    1   0.           0.0008622

  1996may21_00:00:00   Tuesday Pollutant Nr.          2(O2)
 Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
          kg/s       kg/s             kg/s       kg/kg
     1.00        1.00              1.00        1.00
 ----------------------------------------------------------
   zon1    0.        -5.805E-06   1   0.           0.2317

 Steady state solution:
 ----------------------

  1996may21_00:00:00   Tuesday Pollutant Nr.          1(CO2)
 Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
          kg/s       kg/s             kg/s       kg/kg
     1.00        1.00              1.00        1.00
 ----------------------------------------------------------
   zon1    0.         6.626E-06    1   0.           0.0008621

  1996may21_00:00:00   Tuesday Pollutant Nr.          2(O2)
 Zone-ID Source Occupant-Source  NrOcc Sink    Concentration
          kg/s       kg/s             kg/s       kg/kg
     1.00        1.00              1.00        1.00
 ----------------------------------------------------------
   zon1    0.        -5.805E-06   1   0.           0.2318

 COMIS finished. 5 timesteps.  There are 6 messages,marked as ***CER*** in your
```

CER/COF file.